AGRICULTURAL ENGINEERING

JUNE • 1946

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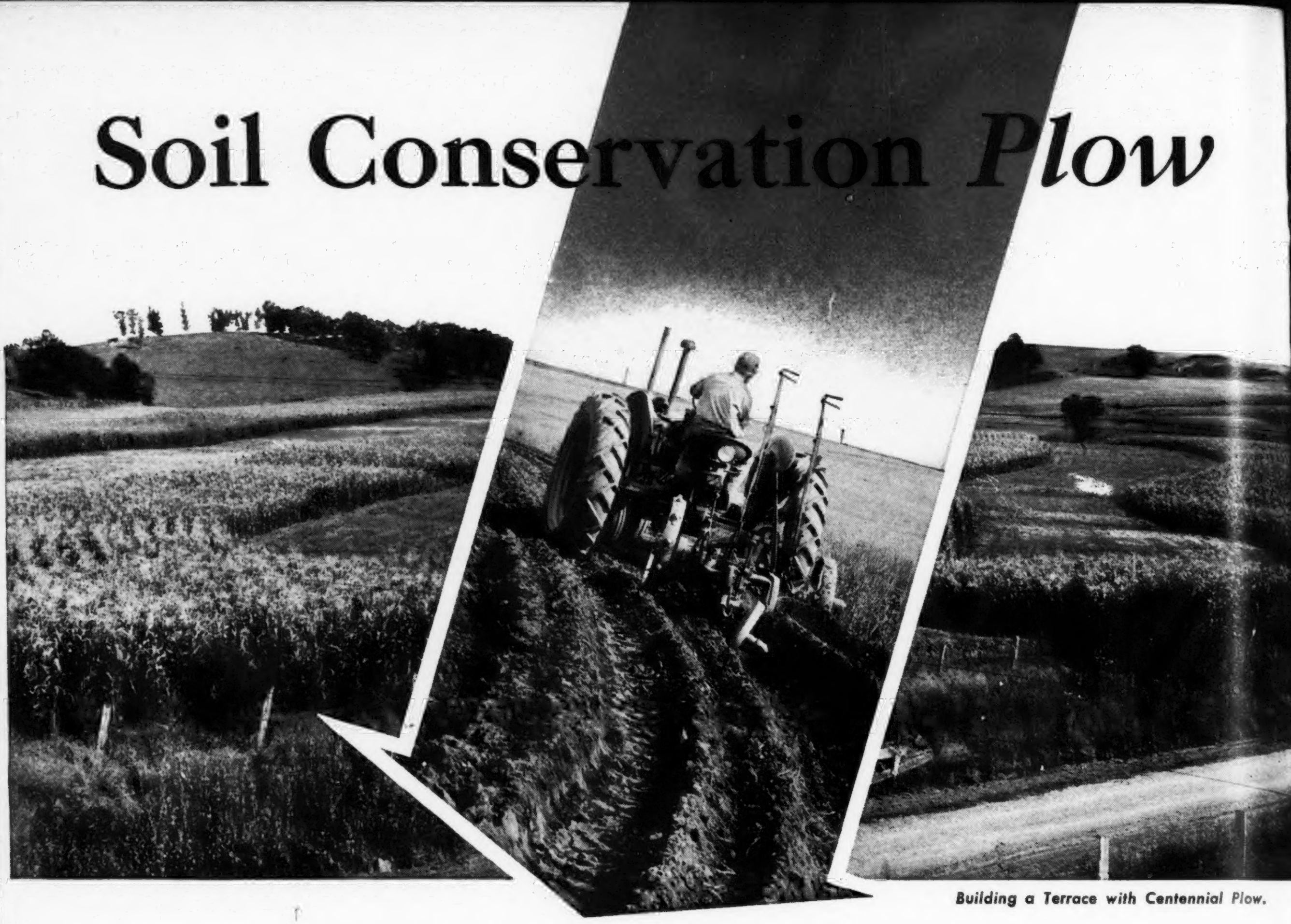
ASAE

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Soil Conservation *Plow*



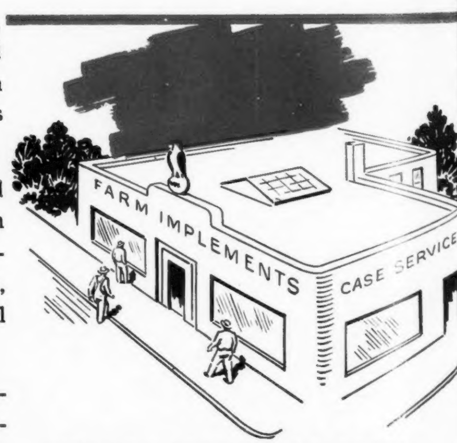
Building a Terrace with Centennial Plow.

• • a Century *of Knowing How*

WHEN the Case plow business began in 1837 at Grand Detour, Illinois, it made moldboards of hardened steel, to see if they would scour in the prairie soils, sticky as were those soils with their rich stores of humus. That successful experiment was the start of endless research which steadily built up a fund of "know-how."

A century later came the Case Centennial plow, again a practical aid in solving a problem of American farming. This time it was erosion and depletion of soil; not too much but too little humus. Case "know-how" provided clearance and covering capacity for bulky crop residues, rank cover crops, tall weeds. More than a tillage tool, the Centennial is a practical implement for building terraces, ditches and ponds.

In the development and demonstration of soil conservation procedures with regular farm equipment, Case has had the hearty cooperation of agricultural engineers in public employ, notably in the Soil Conservation Service and the state colleges of agriculture. In turn, Case has fostered cooperation with public agencies by its engineers, field organization and dealers for the furtherance of conservation practices. Educational booklets, charts, and full-color movies created by Case are freely available for your use. Ask for detailed list. J. I. Case Co., Racine, Wis.



HEADQUARTERS FOR FARM EQUIPMENT TO APPLY THE ADVANCED PRACTICES

CASE

AGRICULTURAL ENGINEERING

Established 1920

CONTENTS FOR JUNE, 1946

Vol. 27, No. 6

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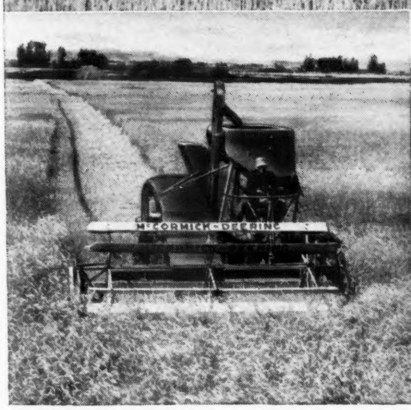

McCormick-Deering 123-SP Self-Propelled Combine opens up a field with no backswath. *Below:* The 123-SP, with pick-up attachment. Other McCormick-Deering combines—pull-type, hillside, rice.

EDITORIAL

Agricultural Engineers and Farm Safety

FOR several years the Committee on Farm Safety of the American Society of Agricultural Engineers has been looking into specific farm accidents for information to be gained from them and applied toward preventing their repetition. Perhaps the time is ripe for the Society to give further support to the Committee and to the farm division of the National Safety Council.

For one thing, C. L. Hamilton, assistant director of the N.S.C. farm division, suggests that concerted thought and discussion on the engineering pattern of farm hazards and safety measures would help to unify our viewpoints on the matter and point the way to further constructive activity.

Continuing accidents show that it is not enough to warn people to be careful. Sound engineering can make it easier for farmers to be careful, and reduce the need of special care at many points. Probably most farms have more specific hazards than the farmer can keep in mind along with his daily work, and more than any engineer, other than a safety specialist, could observe and list at one inspection.

Farm organizations, farm papers, and national leaders are strongly behind the farm safety movement. However, we are convinced that engineering — agricultural engineering, to be specific — is involved in the overall problem to such an extent that agricultural engineers have more to contribute to the movement than is generally realized. In fact, it would seem that the initiative is up to them to determine the ways and means by which engineering can serve farmers from a safety standpoint. It is only logical for engineers to do engineering work, and to look to other related interests to help provide support for the work and to encourage widespread use of its results in the form of practicable safety measures.

Built-in Mechanical Safety

MANY agencies are doing good work to promote farm safety, including the National Safety Council with its farm division, the Farm Equipment Institute with its safety committee, and the American Society of Agricultural Engineers with its Committee on Farm Safety,

But in spite of all this there are too many accidents on farms, many of which are fatal. What is wrong? Putting safety caution signs on farm equipment seems a logical thing to do; however, it will not put common sense into the head of a careless operator. The caution sign, "Keep Hands Away from Rolls," will not prevent farmers from getting caught in the snapping rolls of corn pickers. Putting a warning notice on a tractor will not prevent it being driven at an excessive rate of speed or keep the driver from falling from the seat on account of sleepiness.

It will take more than a warning sign to make most of such units safe to operate. One cannot injure fingers in gears that are enclosed in a case; such a safety measure is really safe. One could not have a serious accident by falling off the seat of a tractor if it had an enclosed cab. Starting a tractor engine when the machine is in gear is impossible when devices are built into the tractor to prevent it.

Power-take-off guards that would make the unit inoperative if the guards were removed would prevent accidents from this source. Devices to prevent access to snapping rolls of corn pickers when they are running would save hands, arms, and lives.

Engineers are trained to develop good, efficient, units at low production cost in order to reduce the sale price and open the market to more farmers. At the same time, most farm equipment has been made more than reasonably safe when maintained and used with a fair degree of judgment. But the records show that this is not enough. Even a normally safe operator will at times make dangerous mistakes. The next step is to reduce dependence on proper operation to provide safety and to build machines so that fewer mistakes in use can be made. Unless carefully designed, safety guards and devices may add considerably to the cost of a unit. However, engineers do have a responsibility toward farm safety. More safety can be built into farm machinery if engineers really apply themselves in that direction, and the cost will be slight.

F. N. G. KRANICK

Cooperation in Research

IN these troubled times it is a source of satisfaction to note instances of increasing voluntary cooperation between individuals and groups doing separate jobs that must be tied together to amount to any significant contribution to human welfare.

Two such instances in our own field are evident in conferences this year between public service research men and engineers of the industries through which results become available as aids to farmers.

The industry-research conference held at Alabama Polytechnic Institute and the Tillage Machinery Laboratory of the U. S. Department of Agriculture, at Auburn, Ala., February 15 and 16, was a logical sequel to a similar successful conference held at the University of Illinois last year. Cooperating sponsors included the Farm Equipment Institute, Alabama Agricultural Experiment Station, U. S. Soil Conservation Service, and the divisions of agricultural engineering (BPISAE), U. S. Department of Agriculture. Representatives of both large and small manufacturers of farm equipment were present to discuss with agricultural engineers and others in public service research the mechanical equipment needs and problems of the region, to see some of the research in progress, to ask questions, and to offer suggestions, and the conference was followed up with a summary report to extend its informational output to interested engineers in the industry who were unable to attend.

The animal shelter research conference at the Missouri Agricultural Experiment Station, April 5, was a case of calling in and consulting representatives of the building materials and equipment industry on the detailed planning of a major public research project of vital interest to them as well as to agriculture. In fact, the project originated in a recommendation from industry submitted on request to the Agricultural Research Administration of the USDA. The industry representatives were able to contribute valuable suggestions on information to be sought in order to improve the application of building materials and equipment in farm use, and on methods and techniques to expedite the project. Here again a report of the conference was made available to the entire industry. With this groundwork of thorough preparation and mutual understanding the prospects are good that it may prove the most useful and significant animal shelter research since man first built a lean-to.

Pure science research may well continue to nose about here and there for academically *(Continued on page 262)*

HAYING...
without pitchforks

Operated by power take-off this field harvester mows, picks-up, chops and elevates a 3-ton load of alfalfa for silage in only 10 minutes.

It places its load in a modified manure spreader with a built-up box—which permits unloading by use of the drag apron within the box.

This ingenious method was devised by B. S. Knapp, Monroe, Michigan, to prevent harvest-time losses in hay quality; get rid of the hot, dusty manual labor of haying; make better use of storage space; provide the equivalent of fresh pasture during the dry season; make feeding and bedding of livestock a shorter, easier job.

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AGRICULTURAL ENGINEERING

VOL. 27 JUNE, 1946 No. 6

Engineering Farm Safety

By C. L. Hamilton
MEMBER A.S.A.E.

THE President of the United States has called upon the nation to observe the week of July 21 to 27 as "National Farm Safety Week." All persons and organizations concerned with agriculture and farm life have been requested to rally in a united campaign against farm accidents. The campaign is endorsed by the Secretary of Agriculture and leaders of the national farm organizations. Special activities will be sponsored by the National Safety Council in cooperation with the U. S. Department of Agriculture and state farm safety week chairmen.

National Farm Safety Week should remind agricultural engineers of a challenging, unsolved, year-around problem. It is security from needless death, injury and suffering for 26,000,000 farm people. To win the struggle against farm accidents, engineers and other farm leaders must pool their resources. It may take even more resourcefulness and strategy than required for conservation of food, soil or other national programs. A clearer and more comprehensive method of attack is needed badly.

America has been called the most wasteful nation of the world. Our food wastage is being publicized. We have been accused of wasting soil, minerals, timber, oil and other resources. Now comes another charge: America is wasting lives, our most vital resource, and it appears to be well founded when you review accident statistics and estimate the total loss to agriculture or the nation.

Our war cost was high because the leaders choose any sacrifice of material or equipment that would reduce the chances of losing men. The same determination to preserve life has made America a leader in the battle against disease. There is no more need for suffering an annual national accident rate, that is greater than our losses to enemy action in the war just ended, than there would be for tolerating the typhoid rate of 50 years ago. Agriculture has a major stake in this national problem.

A review of the progress and achievement in industrial safety may serve as a background for similar development in agriculture or indicate possible avenues of approach. Agricultural adaptation may be developed from the basic accident prevention principles proven by industrial usage. Industry's achievements should at least serve as a challenge to agricultural leaders.

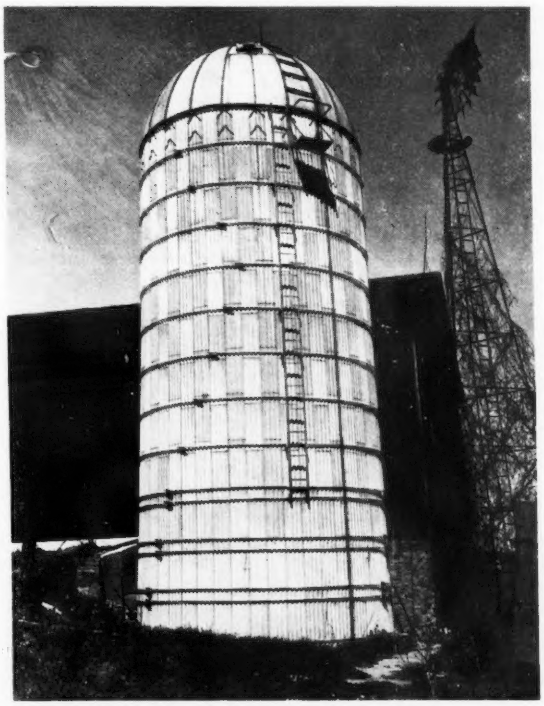
Industry Blazed the Trail. Workers in the organized industrial safety movement can see the results of their progress in living, healthy people. They know that something like 20,000 people are alive today who would have been killed last year if the accident death rate of 30 years ago had not been reduced by an organized battle for safety. They also know they have not reached their ultimate goal. In case after case they have proven that accidents can be eliminated.

You know what a factory was like years ago. It was a dark, ill-ventilated fire trap packed to the rafters with mazes of pulleys, shafts and belts transmitting power from a central steam engine or waterwheel to all sorts of machines. Neither the belt nor the steel jaws and teeth of the machine were guarded in most cases.

During the same period management reasoned that accidents were always happening; that they were acts of God. Or maybe they were just the result of stupidity of the hired hand. If a worker donated a hand to an unguarded punch press, or lost an arm in a giant pulley, he was just careless, or he didn't "live right." When a man slipped and fell on a greasy floor, perhaps the janitor was blamed. Or if there was a fire, it was either God or a careless smoker who was blamed. Sometimes, of course, the wrong man was injured yet no one in authority assumed responsibility.

Fortunately a few far-sighted engineers refused to follow the conventional pattern of the time. They shouted long and loud for better lighting, better ventilation, guards on machines, elimination of hazardous belt drives, rearrangement of work to eliminate handling hazardous material. They called for adequate first-aid equipment and attendance. They waxed eloquent on the necessity of good housekeeping in the plant to eliminate both fires and falls. And so on down an endless list.

A growing sentiment for workmen protection developed with the clergy, the press, and the labor union as its voice.



This silo has a much better ladder and platform than most farm silos, but note how inconvenient and hazardous it is to transfer from the ladder to the platform

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

C. L. HAMILTON is assistant director, farm division, National Safety Council.

Led by New Jersey, state after state passed workmen's compensation laws in the second decade of this century. Every state in the union except Mississippi now has such a law. These laws place the financial responsibility for work accidents on the employer.

Management, once its attention was forcefully called to the importance of safety, made some astounding discoveries. It learned that a program of accident prevention in a factory or on a railroad led to efficiency as well as safety. It learned that safety had to be built into the factory, planned into operations, and maintained aggressively. Engineers trained for the job were employed; regular inspection and meetings became common.

Improved lighting reduced accidents, but it also speeded production. Better ventilation reduced fatigue. Workers on guarded machines moved more swiftly. Individual drives eliminated hazardous belts as well as inefficient central power systems of the old days. Efforts to eliminate handling hazardous material resulted in a whole new science of time and motion study that grew up in the interest of speedier production, quite apart from safety considerations. First-aid setups cut down time lost while waiting on physicians to care for slight injuries.

This inexpensive homemade hook makes coupling (left) of a tractor to drawn equipment easier and safer; and when it is reversed, it serves as a drawbar pin (right) and facilitates uncoupling

The A.S.S.E. As accident prevention became recognized in industry, the safety engineers employed for the job found they had common problems and objectives, so they naturally joined together in the formation of a national organization — the American Society of Safety Engineers. The objectives of this society are to promote the art and the sciences connected with engineering in its relation to accident prevention and conservation of life and property, and to encourage the development of safety engineering as a profession. The Society's growth and activities parallel the growth of safety work in industry.

Farm Safety Needs Factual Direction. Even though farm safety is in its infancy, it is fast gaining momentum. Within the last few years practically every state has promoted some definite safety educational activity. Sixteen states have established permanent farm safety committees to initiate team work and correlate resources of interested state agencies. Some states are now organizing similar setups at the county level. Seven states now employ full-time farm safety specialists. Other states are making arrangements to add safety specialists. Beginning June 1 one state will have two full-time farm safety specialists. These events will be recorded in our history books because they date definite action in establishing a new field of agricultural education and research.

Farm safety has already received considerable publicity and many educational projects are now under way. The promotional type of activities has of necessity predominated. This type of initial approach is desirable to gain interest and support of influential agricultural organizations or agencies. It is also necessary to arouse public interest.

Now there is a need for more basic criteria and engineering analysis to keep the movement on a sound footing. Even an important or progressive movement cannot produce results or survive if it is largely based on assumption, intuition or opinion. Much time and effort can be wasted in trying to establish ineffective practices or practices that account for very few accidents. The services of trained specialists are required. More research on types and causes is necessary. Classifications which simplify educational activities and program development should be established. Specific farm job analysis to determine the most acceptable safety techniques and other basic fundamentals is needed. Farm safety will lack factual direction until more of this basic criteria is developed.

Statistics on farm accidents which show the extent, type and causes in any state or community is a basic requirement in developing effective accident prevention recommendations. This information will show how accidents occur, indicate remedies and serve as a yardstick for measuring accomplishments. Extensive cause analysis may be necessary to determine the most practical remedies. Until arrangements can be made to secure periodic farm accident information through regular state or national agricultural census channels, it will be necessary to depend on informal supplementary local surveys by rural schools, clubs, physicians, newspaper clippings or similar sources.

Engineering revision is the first approach that should be taken in determining sound accident prevention or corrective measures. When applicable it provides the easiest, quickest, cheapest and most effective accident prevention remedies. It involves changing, relocating, eliminating, guarding or substituting one thing for another. It involves "on the spot" analysis of individual farm jobs. Sometimes it leads to changing the entire job method. This approach is not only basic for faulty mechanical or physical conditions, but it may also provide the best remedy for accidents arising out of unsafe or improper practices of persons, particularly in cases where conventional methods are difficult, inconvenient or uncomfortable.

The engineering revision approach applies to all phases of farm safety — the home, farm work, highway travel or recreation. Fortunately, the development of safer ways to do farm work often goes hand in hand with easier and cheaper ways. When the safe way is also easier and cheaper, the problem of securing execution is simplified. In some cases engineering revision will not be practical. It will then be necessary to rely solely on educational activities to change the personal habits of individuals. *(Continued on page 260)*

Engineering Classification of Farm Accident Hazards

By Ralph A. Palmer
MEMBER A.S.A.E.

THE observance of National Farm Safety Week, July 21 to 27 of this year, recalls attention to a fact which agricultural engineers need to remember every week and every day, namely, that they and their farmer clients regularly and necessarily deal daily with forces, weights, elevations, motions, shapes, temperatures, chemicals, and forms of life far more dangerous to them than the atomic bomb. Safety engineering is an important adjunct to agricultural engineering and commands serious consideration as such.

The farmer must of necessity be a jack-of-all-trades for he must successfully deal with the forces of nature and those devised by man. An analysis of hundreds of farm accidents made by the Committee on Farm Safety of the American Society of Agricultural Engineers reveals that most of the accidents occurring on the farm are the result of carelessness. Farm people must become safety conscious, and this can be accomplished by means of an intensive educational campaign. Agricultural engineers must become more safety conscious to do their part in this and other means of improving farm safety.

The gist of the problem, so far as agricultural engineers are concerned, seems to be that safety is only one of the many considerations demanding attention in their work. In this situation, anything which will make it easier for agricultural engineers, consciously and unconsciously, to give more attention to safety angles, should pay dividends in reduced accidents.

One such help would be some simple classification of hazards, which would be photographed on the mind with a little use, and which would help the engineer like a sixth sense almost automatically to anticipate, identify, recognize, analyze, and avoid or correct the hazards continually cropping out in connection with his work. A trial hazard classification outline is shown in Table 1.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

RALPH A. PALMER is assistant secretary, American Society of Agricultural Engineers.

AUTHOR'S NOTE: The author is indebted to C. L. Hamilton of the National Safety Council and to Theo. Brown of Deere & Company for helpful suggestions in connection with the preparation of this paper.

BASES OF CLASSIFICATION

Elementally, hazards may be classified according to the parts of the body exposed, the reason for their being exposed, and the possible sources of a knockout punch.

Parts of the Body Exposed. This is of some concern to the engineer in that, in some cases, special protection can be provided for delicate organs such as the eyes and ears, for the hands and feet which often reach out to meet danger more than half way, and for the mouth and nose through which internal organs may be exposed. However, many hazards are of such a nature that any or all parts of the body are endangered.

WHY PEOPLE TAKE CHANCES

Reasons for exposure, as a source of farm accident hazards, are mostly either economic motives or mental conditions responsible for unguarded actions.

Economic Classes of Risks. Economically, hazards may be clearly justifiable, unjustifiable, or borderline cases.

1 *Justifiable risks* are involved in use of the pocketknife, the friction match, the cookstove, the farm tractor, and the hay chute, among thousands of other useful articles. The safety problem is obviously one of proper use and safeguarding, rather than disuse.

2 *Uneconomic hazards* often arise as incidentals of operations — the upturned nail, the misplaced pitchfork, the slick oil spot, and the accumulations of trash. This class of risks can also develop in beautification projects, where the safety factor is overlooked, and may range from a view-obstructing lilac bush to a beautifully waxed, and treacherous, stairway. Depreciation—the broken step or sharp piece of glass — is another source of hazards under this title. Still another is simple neglect to provide and maintain reasonable safeguards.

Left: Cluttered, winding steps give falls a double break. These accident traps can be eliminated with straight stairs and adequate storage facilities for household equipment • *Center:* Doors that swing directly over steps create a farm fall hazard. At least a 30-in landing should be provided to eliminate this hazard • *Right:* Improper design and neglected repairs make the majority of barn ladders hazardous and inconvenient

3 *Marginal Cases.* Hazards that may or may not be worth the risk are to be expected in potentially useful articles which are improvised, jerry-built, low in material or quality to meet price competition, lacking in safeguards, or otherwise poorly engineered. In many cases the unsafe item can be improved or replaced with a device which will do the job economically, and safely. The electric fence is an example of a device which must be well engineered to reduce the risk to a point where it is clearly justified. Notable progress in eliminating this economic class of hazards in the special field of fire safety has been made by underwriters' inspection and labelling.

Persons as Subjects for Protection. Hazards may be further classified according to the contributing human factors which make man a difficult subject to protect from danger. From a safety engineering standpoint, and notwithstanding his five warning senses, man must be regarded as poorly adapted to look out for his own safety anywhere outside of a padded cell.

These personal hazards can be grouped roughly into those caused by lack of knowledge, neglect to take known proper action, and the taking of known improper action.

1 *Lack of knowledge* of an existing danger causes unpredictable action. It must be anticipated where access of children or other uninformed persons is probable; where an attractive nuisance is created, and where potentially dangerous forces, objects, or materials of any kind are introduced into a new environment. Means of minimizing this class of hazards include locks, enclosures, warning signs, guards, proper lighting, complication of controls so that only informed persons can put machines into operation, alarm devices, automatic stops, deterrent and warning odors and tastes in the case of chemicals, good housekeeping, and instruction.

2 *Neglect to take known proper action* frequently arises from indifference, laziness, careless familiarity, contempt, habit, absentmindedness, daring, hurry, and temporary dulling of the senses by overconcentration, lack of concentration, monotony, depression, preoccupation, alcohol, lack of sleep, and other causes. Use of damaged tools, improper placing of tools and work, failure to follow proper work methods, failure to use available safety devices, and accumulations of debris are examples of this class of setup for accidents. Even skilled operators cannot be depended on always to take the precautions they know should be taken for their own safety. Indicated measures for reducing this class of hazards include visual, auditory and other warnings, safe operating procedures, debris collectors, guards integral with machine frames, controls which prevent operation until certain safety measures have been taken, and controls which stop operations automatically when parts of the body, tools, or work approach danger areas.

3 *The taking of action known to be improper* and dangerous results from some of the same causes, but generally from misdirected positive qualities such as ambition, pride, elation, curiosity, and playfulness. Poor judgment, desire for a thrill, lack of foresight, and unconscious reaction are other contributing factors. Excessive speeding of vehicles or other machine operations and walking or reaching into known dangerous places are common examples. Add to previously mentioned safety measures speed governors, overspeed and overload warning devices, rules and penalties, and safety record incentives.

DANGER FACTORS IN FARM ENVIRONMENTS AND ACTIVITIES

Likely sources of a knockout punch are readily named in terms familiar to the engineer. Basically they are conditions of form, relative position, and energy temporarily out of control of the victim.

TABLE 1. HAZARD CLASSIFICATION OUTLINE

Bases of classification, and subclasses	Typical situations or locations in which hazards are to be anticipated	Some available preventive, corrective, or risk reduction measures
I *Parts of body exposed*		Special shielding betwee[n] body parts and sources of hazard
A Delicate parts	Flying particles	Goggles
B Openings to internal organs	Dusts and chemicals	Respirators, shields to prevent contamination o[f] foods and drinking wat[er], ventilators
C Reaching parts	Moving machinery, sharp edges or points, poor footings	Safety shoes, gloves, limit marks, non-slip flooring
II *Reasons for exposure*		
A Economic classes of risks		
1 Justifiable	Standard or common materials or devices	Safe operating procedur[es], instruction, inspection, built-in safety factors
2 Unjustifiable	Incidentals of economic operations, accumulations of waste, leakage, depreciation, devices made obsolete by development of safer structures or equipment	Maintenance, good housekeeping inspection replacement
3 Borderline cases (purpose economically sound but means of accomplishment questionable)	Home-built, improvised low-quality, poorly-engineered construction or equipment	Improvement or replacement of dangerous items or features; use of alternative methods or equipment
B Contributing human factors		
1 Lack of knowledge	Wherever experience or special skills are required for safety	Instruction; exclusion of unqualified
2 Neglect to take known proper action	Repeated operations, habitual procedures	Warnings, alarms, deterrant devices, safe-operating procedures, mechanical aids
3 Taking of known improper action	Groups of boys; signs of indifference, carelessness or incompetence	Safety incentives, integral safety features not easily removed
4 Physical incapacity to recognize hazards or take preventive action	Aged, small or otherwise handicapped persons	Warnings; adaptations of equipment to users; improved lighting spectacles
III *Common environmental sources of danger expressed as basic physical characteristics*		
A Dangerous forms		
1 Sharp points and edges	Pointed or edged tools, fresh cuts or broken edges, splintered wood, used lumber	Good housekeeping, special shields
2 Rough or poorly shaped working surfaces	Benches, platforms, handles	Smoothing, reshaping, or replacement
3 Projections	On moving parts, in or near path of movement of persons or animals, or where not readily seen	Removal, shielding, and warnings
4 Dust and smoke	Around grinders, fires, and machines for mixing or moving finely divided dry matter	Collectors, ventilation
5 The inverted wedge	Openings into which the hands, feet, head or whole body may be squeezed, where attempts to remove tend to reduce the size of the opening	Elimination, enlarging warnings
6 Airtight spaces	Silos, tanks, small rooms, cisterns	Additional openings, easy exits, warnings, instruction
B Relative position		
1 Obstacles to movement	Low beams, littered pathways, materials, tools or finished work in the way of machine parts	Removal or warning
2 Obstacles to vision, hearing or other warning senses	Poor lighting, noise, "blind spots"	Removal, warnings, reflectors
3 Location of openings	Top openings, openings easily blocked without warning	Additional openings, warnings
4 Location with relation to unstabilizing influences	Inflammables or explosives close to heat, Foundations and bases	Move storage or source of heat, or provide insulation Protect from mechanica[l] damage, slippage, or shifting of supporting material

Form Hazards. Forms to fear and avoid include not only visible projections, splinters, sharp edges and poor working surfaces, but dust, the inverted wedge, the slip noose, and the airtight space. However clear the danger on calm reflection, it is often overlooked in the pursuit of immediate objectives, until too late. Even the simple glass lens, misplaced, has been known to cause fires.

Directional and Dimensional Dangers. Relative position is a factor in form and energy hazards often arising from the elementary physical fact that two things cannot occupy the same space at the same time. Checking of clearances and routings for body, machine, and material movements is implied. Location of openings is a consideration. A silo or tank with large openings at the top may prove a mantrap baited with safe appearance but permitting accumulation of deadly or heavy gases to the exclusion of oxygen. Positioning of controls and emergency outlets has considerable bearing on hazards. Several people were left "so near but yet so far" from safety in refrigerated storage rooms before it became standard practice to make the door latches so they could be opened from the inside. With controls the question is, Are they so located, evident, and easy to operate that they can be used to stop the machine, open the door, or give an alarm, by the person endangered, and possibly already injured?

The Power Behind the Punch. In the energy class, *static or potential energy* easily appears harmless and probably packs more sad surprises than kinetic energy. The static energy of a supported weight, a compressed spring or gas or an explosive is often deceptive as to the time and manner in which it may be released, the directions in which it will dissipate its strength, or even its existence. Ropes, cables, and timbers may become dangerous springs when stressed near their breaking strengths. A plug unscrewed from a tank, if there is pressure behind it, may become a bullet. The energy of the human body in a standing position, when released by a fall, is itself sometimes enough to break a bone. Caution suggests a suspicious look as to the stability, support, and security of structures, scaffolding, underpinning, storage, items piled high or on end, overhead objects, loads and weights on sloping surfaces; as to supposedly empty tanks, clouds of combustible dust, storage and use of combustible or otherwise dangerous chemicals, and grounding of buildings and electrical systems; and as to provision of adequate clearances, footings, guardrails, handholds, and safety belts. Wherever large, dangerous, or valuable static energies are maintained over some period of time, the probable effect of one or more natural phenomena becomes a design factor and cause for reinspection. The loading, weakening, and unstabilizing effects of extremes of heat or cold, wind, rain, flood, snow, earthquake and lightning are well known but often overlooked or accepted needlessly as uninsured risks.

Kinetic energy can also be deceptive. Machines may run so smoothly as to hide the energy behind them, or so noisily as to distract attention from other hazards. Turning projections and abrasive surfaces tend to look more round, smooth, and harmless as their angular velocity and capacity to injure are increased. High-speed motions create large inertia forces. Cumulative vibration forces may arise unexpectedly.

New hazards of radiation are being introduced on farms, incidental to new useful equipment and processes. They may give no warning until the damage is done. New applications of heat in varying degrees and new heat-producing processes and equipment may be tricky.

From a safety standpoint, kinetic energy in the nature of feeding, entrapping, entangling, grinding or shearing motions; high-speed motions; turning motions and centrifugal forces; free, uncontrolled movement, as of flying particles; intense or cumulative heat; radiations; vibration; concussion, and electric currents—all these offer major hazard possibilities. They are subjects for accident prevention by appropriate warnings, controls, shields, automatic feeders, design strength and refinement, chemical treatment, safe operating procedures, emergency equipment and procedures, and regular inspection.

These classifications are condensed and summarized separately in Table 1. They are presented not as a finished product, but as a suggested possible starting point for development of the engineering pattern of farm hazards, the mental outline which will help make specific hazards, actual or potential, stand out like neon signs.

Other classifications of hazards are possible. The important thing for an agricultural engineer — especially important because he often may lack ready access to the services of a specially trained safety engineer — is that he have thoroughly ingrained in his mind the basic conditions of safety, and types of hazards, so as to recognize and identify them easily on the ground, in experimental models, in drawings, in descriptions of proposed plans, even in the cold figures of strength and dimensions. Then safety consciousness will be reflected in his designs, his applications, his teaching, his advice to farmers.

Agricultural engineering developments in equipment and construction have created some farm hazards. These and most of the others involve forces and materials and are susceptible, in greater or less degree, to engineering means or reduction or control. Farm safety offers a tremendous economic and humanitarian opportunity for sound engineering, and for agricultural engineering cooperation with other interested groups.

TABLE 1. *(Continued)*

Bases of classification, and subclasses	Typical situations or locations in which hazards are to be anticipated	Some available preventive, corrective, or risk-reduction measures
5 Location of controls and emergency equipment	Out of reach from point of danger, not readily visible	Relocation and marking
C Energy		
1 Static or potential energy		
(a) Supported weight	Structures, stacks, piles, scaffolding, hoists, jacks, floors, roofs, loose small tools and supplies overhead	Design strength, inspection
(b) Compression or distortion	Springs, pressure tanks, loaded ropes, cables, or levers	Warnings, shields, safe-operating practices
(c) Unstable chemicals	Explosives, inflammables, volatile liquids, acids, alkalies, poisons	Warning signs, secure storage under favorable conditions
(d) Electrical potential	Power wires and equipment; ungrounded surfaces subject to static charges	Grounding, warnings, lightning rods, lightning arresters, separation of inflammables and explosives from path of static discharge
2 Kinetic energy		
(a) Motion of materials		
(1) High-speed motions	Vehicles, saws, grinding wheels, pulleys, belts, flywheels	Governors, warnings, shields
(2) Feeding, entrapping, entangling, grinding, or shearing motions	Points where material feeds into machines	Guards, shields, warnings, controls, automatic stops
(3) Uncontrolled free motion,	Flying particles, falls, dropped tools and materials, unpredictable action of animals	Shields, good footings, good housekeeping, structural and mechanical controls, safe-operating practices
(4) Vibration	Cumulative, continuous	Elimination, inspection
(b) Radiation	Ultraviolet, infrared, supersonic	Safe-operating practices, exclusion of uninformed
(c) Chemical action	Storage, handling, use	Warnings; instruction, safe-use practices, exclusion of uninformed; proper handling equipment

Design of an Onion Storage Warehouse

By S. A. Witzel

MEMBER A.S.A.E.

DURING the summer of 1943 the author worked with one of Wisconsin's leading onion and potato producers, Emery Owens and associates, in the investigation, development, designing and construction of an onion storage warehouse which would hold approximately 600 carloads of onions. Considerable investigational work on the storage of onions had been carried out cooperatively by Mr. Owens and the author over a period of about ten years, prior to the designing and construction of these storage warehouses.

The first warehouse constructed consisted of a basement for the storage of potatoes, and an insulated wood superstructure for the storage of onions, with a storage capacity of about ten carloads.

The capacity of the first structure was found inadequate during a year of high production, and an empty dairy barn was insulated with chopped marsh hay which proved to be a very satisfactory onion storage warehouse when properly operated. A fire in the original potato and onion storage warehouse made reconstruction necessary. Improved design and better insulation provisions relieved the necessity of applying artificial heat, and likewise reduced the fire hazard by eliminating the need for stove heat. The next step was the construction of two basement and wood frame onion and potato warehouses with a drying and grading shed along one side of one warehouse. The basement wall, insulated above the ground line with tile cast in place with the concrete wall, served as a potato storage warehouse. A tight double board floor permitted the maintenance of suitable humidity conditions for potato storage in the basement while the two upper floors were maintained dry enough for onion storage purposes. The storage capacity of these two warehouses is in the neighborhood of 50 carloads of onions each. Ventilation was afforded by the regulation of well-placed doors, slatted floors and onions stored in sacks stacked three sacks high. Temperatures were maintained just above freezing throughout the winter.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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Since the construction of the large new warehouse, it has been operated through three seasons. The first season the warehouse was built, it was about two-thirds full, and the last two years a large crop filled it to capacity. The operation of this building has been very carefully watched during the past three storage seasons, and losses have been very small when operated according to the method of operation followed. The onions sacked in the field were dried on wood platforms when the ground was wet in groups of about ten sacks. When the onions in the sacks are thoroughly dried, they are picked up on four-wheeled, dual-tired, heavy-duty trailers, hauling between three and four tons each. These trailers are pulled by track-type tractors to gravel roads through the marsh and are hauled to the storage warehouse with an ordinary general-purpose tractor.

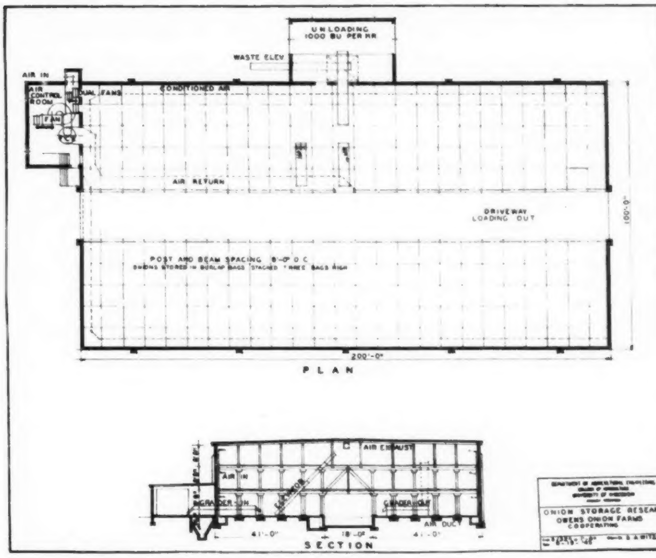
At the warehouse the onions are run over a grader at the rate of 1000 bu per hr, placed in clean burlap bags, and conveyed by elevator to the floor on which they are to be stored. A large two-wheeled truck is used to wheel the onions to the point of storage where they are stacked three sacks high. The sacks contain about 1½ bu of onions and are not tied. In this way all of the defective onions, loose leaves and dirt are removed by the grader, the pickers, and by the suction fan which delivers the refuse to a hopper in the floor of the receiving room. From this hopper the refuse is delivered by elevator to a manure spreader with 6-ft sides, which is hauled to the field whenever it is filled.

In carrying on the harvesting operation, wet weather and the slow drying weather of the late autumn are handicaps. Onions placed in storage early in the fall are hard to cool. The fans in the storage warehouse are operated at full capacity on cool nights and shut off during the day. The highest quality onions can be harvested only during the early part of the harvesting season. Some additional plans are being made for the installation of a drier and a cooler so that onions may be harvested during the early season and safely stored. Under the present system of cooling with cold night air, some of the onions harvested during the earliest part of the season have quite a few growers. No count of these growers has been taken, but the loss has not been serious. However, in order to reduce grading time to

Three views of the onion storage warehouse on the Emery Owens' onion farms

a minimum, the more nearly the effectiveness of the storage system can be made to approach 100 per cent survival, the more effective the use of grading labor becomes.

The walls of the storage structure were made with light-weight concrete blocks made of Waylite. The 12-in blocks were filled with light-weight insulation material which in this case was also Waylite or exploded blast furnace slag. The roof of this warehouse was made of 1-in pine boards with 2 in of Celotex laid in hot tar and covered with tar and gravel roofing. In planning the building, critical materials were avoided as much as possible in order to secure WPB approval. The source of supply for framing lumber consisted of native oak timber which could be cut best for tie length stock. With this in mind the design was made for 8-ft posts and 8-ft beams. The logs were cut from the woodlot, sawed and finally worked into the structure with the use of unskilled labor. Skilled labor, however, was used for laying up the blocks and for the installation of the ventilation system. The first floor is of concrete over natural sand, while the upper floors consist of 2x8 joists with 1-in oak lumber for floor boards. The floor boards are spaced about ¾ in apart for ventilation purposes.



Plan and section views of the Owens' onion storage warehouse

The ventilating system in this onion storage warehouse is unique and provides complete control of the air at all times excepting for the temperature limitations when cooling in early autumn. As stated above, mechanical refrigeration is being considered for this purpose. It is possible to recirculate air in the warehouse, to bring in outside air, or to heat either recirculated air or outside air as conditions require. Adjustments can be made to vary the proportions as desired. In addition to the mechanical system of ventilation, a large 12x12-ft door is provided at each end of the building for the driveway. Large wall-type fans near the ceiling of the third floor at each end of the building are provided to accelerate the movement of air from these doors up through the building.

On cool nights early in the fall, the natural and mechanical means of moving air are used to secure a maximum amount of cooling. After cooler weather arrives in the fall a pail of water set at the lower elevation in the driveway will maintain a thin layer of ice over it. This condition can be maintained through the winter with the equipment as it is now installed. It has been observed that the quality of the onions will remain constant throughout the entire winter season at a temperature range of from 35 to 40F in the onion storage areas which can be easily maintained at a humidity which prevents condensation on sidewalls and roof. Furnace heat is seldom required either for heating or for moisture control. A surprisingly large amount of cold outside air can be pumped into the building through the ducts which are placed in the ground along the outside walls of the building and the riser system of ducts running from the main ducts under the floor up along the sides of the building to each one of the floors.

This onion storage warehouse has been operated through three seasons with very satisfactory results. Plans are being made for still further improvement. Observation through the storage periods as well as during harvesting and shipping out periods have provided opportunity to determine improvements needed to obtain more effective storage and reduce labor to a minimum. Early season harvesting, 24-hr operation of storage intake, wagon storage of sufficient onions to take care of the night shift, refrigeration, and forced-air circulation through the bins of onions to make the early storage possible without the difficulty of having a high percentage of growers, and the installation of a horizontal portable conveyor system which would transport the onions from the elevator directly to the point of storage or from the point of storage to the grading out machine, would all tend to reduce the labor required to take care of the onions. The bulk handling of onions in field and storage would eliminate the need for sacks.

* * * * *

IMPROVING LABOR EFFICIENCY

There were two interesting developments on this project. First, prior to the construction of this warehouse, most of the onions from the Dousman Marsh were stored in the stock pavilion at the state fair grounds. All winter long it was necessary for the operators to leave home before daylight in the morning and return after dark at night, driving some 60 or 70 miles a day, to carry on their grading and shipping operations. By constructing this warehouse on their own farm the operation goes on much more smoothly.

A Tiller for Onions. The other sidelight, which perhaps should be reported as a separate research project, was the design of a tiller for onions. The owner had already worked out a very unique system of planting nine rows of onions at one time. He has a fertilizer drill behind which he pulls a large drum roller which in turn is followed by nine single-row planters securely anchored to a planter bar so that all nine rows are accurately spaced. A little over two years ago the owner came to our office and presented his problem. He had been using six garden-type tractor cultivators, and it took six good men to operate these tractors. He did not have six men. Besides, from past experience he knew that it would take from 60 to 100 laborers to take care of the acreage of onions which he was going to have to take care of with some 45 laborers.

The author worked out a system of mounting ten-rotary-tiller-type units on a track-type tractor. Mr. Owens, the owner, and others had been working on the rotary tiller idea, but he requested help on using them. By mounting the rotary tillers on his track-type tractor with part of them to the front and part of them on the rear, he was able to

lift them at the ends of the field and keep the tractor in balance. With some rough sketches and the preliminary computations out of the way, the owner went back to his own machine shop and proceeded to build the machine. The onions were about five inches high and the weeds were as high or higher before the machine was finally rolled out of the shed and taken to the field. After a half hour of adjustment the machine travelled down the rows of onions doing a perfect job of tilling nine rows at a time. It was possible for one man to till all of the onions, and the machine did such a thorough job that it was necessary for him to till only twice during the first season. The narrow row of undisturbed earth on which the onions were grown was very easy to weed out as the weeds did not need to be pulled but were simply pushed out of position. The rotary tiller cut down about 1½ to 2 in on each side of this rib of undisturbed earth. As a result, the 45 laborers were able to keep the onions clean.

Engineering Farm Safety

(Continued from page 254)

When millions of people and years of tradition are involved this is a long, tedious task particularly where immediate personal incentives are not obvious. With only one weapon many educational leaders may become discouraged before they reach desirable goals. To assure success they should be able to offer more than simply "be careful."

An outstanding example of what can be accomplished in one type of engineering revision is provided by the agricultural engineers who standardized tractor power take-offs and provided uniform shielding. This not only facilitated farm safety, but it led to economy in manufacturing and distribution, as well as convenience to the farmer by reducing the number of parts and hitches. Efforts are now being directed to the development of a telescoping shield that cannot be completely detached from the power drive.

There are hundreds of other farm jobs that need the same type of treatment. The job of erecting ensilage cutter spouts will serve as an example. Can this job be eliminated by making the spout a part of the silo, or will it be necessary to equip silos with well-designed ladders and platforms so the spout can be erected with a reasonable degree of safety? Present methods and facilities are generally hazardous and inconvenient. The daily job of climbing silos during the feeding season also needs investigation. The method of hanging tobacco in drying sheds needs analysis for the purpose of reducing fall hazards and improving efficiency. Even the conventional method of getting into haylofts of ordinary barns deserves attention. Well over half the barn ladders now in use are fall traps. Such things as entrance porches, stairways, storage facilities for household equipment and lighting needs attention in farm homes. Methods of servicing and operating all types of farm equipment such as corn pickers, mowers, combines, tractors and circular saws fall in the same category. These are just a few random examples; they may not even cover the most important ones. Local analysis of accident statistics will uncover an endless list of farm jobs that need consideration in each state or community.

Safety must be designed into every-day farm work and living the same as it is designed into modern factories, automobiles and highways. Accident prevention must be completely dovetailed into farming operations so it is readily acceptable as a part of the job. Actual accomplishments will be limited or retarded where safety is treated as an independent or separate activity. Any engineer who can coordinate safety with efficient production will win acclaim.

Engineering revision of job procedures, structures and equipment is so vital in farm safety that it can determine the success and failure of the whole farm safety movement. Agricultural engineers have the know-how if they elect to apply it. There is no other group in as favorable a position to contribute supporting safety practices and techniques or initiate necessary research.

Like other new fields farm safety lacks development, recognition and professional prestige. Safety offered the same unattractive elements for engineers in the industrial field 30 years ago. Today industrial safety ranks with other recognized branches of the engineering profession and thousands of specialists are now employed in this field. Many hold high executive positions. Is there any reason why farm safety cannot develop in the same manner? The field in agriculture is large; the need is great and momentum is building up. What else is required?

Will agricultural engineers and other subject-matter specialists be willing to swing far enough from established endeavors to absorb this new challenge adequately? If the established subject-matter specialists in agriculture continue to let safety slip by, a new group of specialists is bound to spring up in the agricultural field — farm safety specialists. An unfilled demand will not wait even though other projects are competing for attention. Signposts already indicate that the trend toward developing a new group has begun. Is this what we want? Every agricultural engineer should be concerned and establish the engineering phase of this program before it is too late.

Pioneering in the new field of agricultural education and research, these state farm safety specialists—the first full-time specialists at a national farm safety meeting—met at the office of the National Safety Council on May 1st to discuss their mutual problems and state safety programs. They are left to right: F. R. Willsey, Indiana; W. E. Stuckey, Ohio; Miss K. M. Olmsted, New York; F. W. Roth, Michigan, and R. C. Swanson, Wisconsin

Self-Propelled Combines to Open Grain Fields

By C. E. Everett
MEMBER A.S.A.E.

ONE has only to read the newspapers to realize that the war has not yet been won, for famine, the ugly aftermath of war, threatens to destroy much for which we have fought. The simple fact is that there is not enough food for America to live according to its customary high standards and to take care of the hungry hundreds of millions in Europe and Asia as well.

Much of World on Starvation Diet. Nutritionists tell us that the average human being needs 2650 calories daily to keep alive and healthy. Here in the United States, we get about 3300 calories. In Europe they are getting a bare 1500 calories. With shipments of food to Europe falling far below the absolute requirements, it is up to every one of us to do everything possible to bolster that supply, and at the same time maintain an adequate dinner table for our own people as well.

Of the more important food and feed grains that can be combined, including soybeans and grain sorghums, about 152 million acres have been planted this year, compared to about 138 million acres of the same crops harvested last year. However, last year, with favorable weather, we produced a near record crop. This year, unfortunately, there is grave danger of drought taking its toll, at a time when we can least afford to lose a single planted acre.

But there is one practicable way in which we can add to the stockpile of grain from the coming harvest.

In this country a very large percentage of the small grain is harvested with combines. Almost all of those machines now in use are tractor drawn. A few thousand, perhaps 8,000 out of the total of several hundred thousand, are self-propelled,

Saving Grain On Opening Round. In one forty-acre field, any other shape than a perfect square, a combine travels about 1¼ miles in making the first cut around the outer perimeter of the field. When this combine is one of the conventional type, pulled by a tractor, most of the growing wheat in a path about 8 ft wide, all around the field, is trampled down under the tractor and combine. Most of that wheat is lost. On the other hand, if this first round of 1¼ miles is cut by a self-propelled combine, the wheat will be saved. In an average wheat yield in this 40-acre field, there would be about 20 bu of wheat put into the bin with the self-propelled combine, that the tractor-pulled type would have left on the field.

The 1946 crop in the United States of wheat, barley, oats, rye, rice, and edible beans will be harvested from about 120 million acres. Combines of some kind will travel almost four million miles opening up these fields, and if all could be opened by self-propelled combines, of any make, it would be possible to save 60 million bushels of these grains that would otherwise be tramped down by tractors and pull-type combines!

It is only fair to say that even with this loss, which amounts to about two per cent of the crop harvested, combining is still the most efficient way to harvest small grains mechanically. Still, in this emergency and with the critical need for every pound of food that can be provided, it would be sad indeed if, knowing some of this grain can be saved, we who can do something about it would fail to do our utmost to save it.

Every Bushel Means a Day's Bread for 150. If all of the wheat fields in the United States were opened by self-propelled combines, we would recover 32,370,000 bu that would otherwise be wasted, enough wheat to provide a minimum UNRRA bread ration for every man, woman and child in the United States for five weeks. This crop is out in the fields now. Harvest is already in full swing. No one can possibly expect to save all of this waste. But surely we should make an effort to save what we can, and in a sense create food for hungry humans who otherwise might not eat.

Unfortunately there are not enough self-propelled combines in existence to open all the fields. If, however, the 8,000 available self-propelled combines of all makes were to go into the 1946 harvest specializing in the opening of fields and letting the conventional combines cut out the centers, a very large contribution of grain could be made to the famine-stricken world. We have a plan to accomplish that result and we have called its participants "Famine-Fighters."

Famine-Fighter Plan. Through the organized "Famine-Fighters" program it is our plan to bring to every self-propelled combine owner in this country the realization that, by opening every possible field of grain, he will be helping to create loaves of bread that otherwise just would not and could not exist. We are using every means to get this story before the grain farmers of the country. We believe this plan will appeal to any practical farmer because he can understand it.

Here is how the "Famine-Fighter" program works: Farm implement dealers are being asked to contact the owners of self-propelled combines and personally present the plan. At the same time they secure the owner's pledge to open 200 extra miles of fields in 1946. Dealers also make available to farmers a list of the self-propelled combine owners who will cooperate in their vicinity.

Self-propelled combine owners indicate their willingness to cooperate by signing the

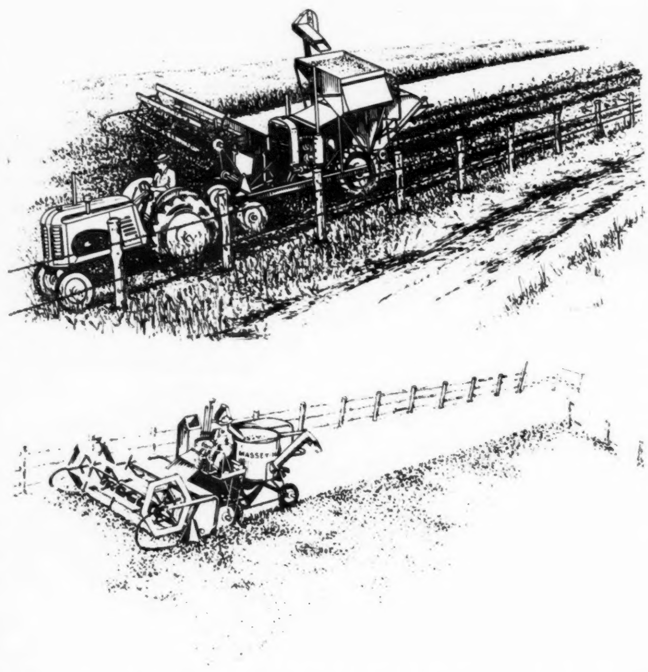
This picture shows the opening round in a field of grain being made with a Massey-Harris self-propelled combine

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

C. E. EVERETT is general consulting engineer, The Massey-Harris Co.

following pledge: "Realizing the urgent need for food to feed a war-torn world, and knowing as well that starving peoples must look to our nation for help, I pledge wholeheartedly to do my share towards saving every possible bushel of grain during the 1946 harvest season. I will use my self-propelled combine to the greatest possible extent in opening up fields because I know I can save vitally needed grain that would otherwise be trampled into the ground."

Dealers have been sent a supply of posters with the request that they personally attend to hanging these posters in their own stores, in banks, grain elevators, anywhere farmers congregate. Dealers were also supplied with a small booklet for wide distribution to people in the farming communities who see and talk to farmers. These posters and booklets are not advertising pieces; they simply tell the story of saving grain and "creating" food.



In the opening round of a grain field, the wheels of the tractor and pull-type combine, shown in the top view, will trample down over 50 per cent of the grain, which will be lost beyond recovery, but by using a self-propelled combine, as in the lower view, all the grain will be cut and saved

Through the farm press and advertising, farmers are being urged to contact self-propelled combine owners and arrange to have their fields opened. After the opening round has been made, farmers will be asked to finish the harvest with their own tractor-drawn combines, so that the self-propelled combines will be able to make their maximum contribution to the food supply by opening other fields rather than handling all of the harvest. If the job is done, farmers will recover $30,000,000 worth of grain which would otherwise be lost, and more important, recover 28,000,000 bushels of grain for the starving peoples of the world.

"Engineering's Economic Environment"

TO THE EDITOR:

REFERRING to the editorial, entitled "Engineering's Economic Environment" in AGRICULTURAL ENGINEERING for April, it is gratifying to see some interest taken in the problems arising from abundant production. Considering only your final question: "Should engineers explore more thoroughly the economic environment in which they and their developments must operate," it seems clear that the answer must be: "Yes, but with the cooperation of interested economists."

Engineering as a profession is intricately involved with costs and profits. In fact, the economic parameter is the main distinguishing feature between engineering and applied physics. Thus economic study is a province of engineers. There is real need for the cooperation of economists, however, in studying problems of abundance, because this involves the interaction of agriculture with the entire national industry. It is recognized that agriculture is already endowed with surplus resources (as indicated by the nearly steady decline in agriculture ratio).

The piecemeal response in our economic system to imposition of controls on shipment of produce is well understood by agricultural economists. So it should be possible for some specialists to extrapolate to the prospective condition of general surplus production, and to determine just what controls are necessary to turn the zero-profit tendency toward a real achievement of abundance.

If producer cooperatives are a valid approach to the problem of handling abundant production, maybe we need also the cooperation of applied psychologists, in that the success in price maintenance by producer dumping offers higher per acre profits to non-dumping minority non-cooperators. The latter get moral support from public disapproval of dumping.

F. A. BROOKS

Cooperation in Research

(Continued from page 251)

appetizing morsels of information. This is one of the most constructive of human activities.

Applied science, which pays the check, is a different activity and demands a different research technique. It demands a meeting of minds to weigh and analyze the problems of the field toward the solution of which science might contribute. It demands analysis of the sciences involved, the state of progress, and the specific data needed and not yet made available or in prospect through other applied or pure science research. It demands a coordinated, efficient procedure to get the specific needed facts not otherwise available. It requires that the facts obtained be made readily available to all interested persons and interpreted into application data, materials, equipment, designs, use methods or whatever may be necessary to get them applied. An applied science research project is not fully completed until the data produced is applied to the fullest toward solution of the specific problem for which it was sought.

In agricultural engineering this implies that the industries, farmers, and public service agencies concerned work together from the selection and planning of projects until the farmer feels the weight of the extra dollar in his pocket. The examples cited may well be copied in this and other fields.

Moisture Losses of Vegetables During Steaming, Quick Freezing and Packaging

By John E. Nicholas, Gilma Olson, Gladys V. Starr, and Thelma Y. Cones
MEMBER A.S.A.E.

RECENT trends in frozen food storage indicate advantages in freezing before packaging, particularly where large quantities are processed. The ultimate goal is a product which will retain its attractiveness, its palatability, and its nutritive value until consumed. One of the principal functions of packaging is to preserve quality. The general practice has been to freeze food in packages, but the turnover of frozen foods has been rapid and the over-all requirements of packages have not been determined. If foods are to be first frozen and then packaged, it may be necessary to incorporate different characteristics into packages to meet successfully the requirements imposed by this new technique.

During the freezing process a product passes through three definite stages in the low-temperature environment. The first stage, precooling, ranges from the initial temperature to 31 F (degrees Fahrenheit). The second, freezing, is the time during which solidification or maximum crystallization of the moisture content in the product takes place, and is commonly referred to as the "zone of maximum crystal formation". Temperatures during this interval remain relatively constant and range from 31 to 25 F. In the third stage the product is subcooled from 25 to 0 F.

The most significant observation heretofore recorded[3]* is that packaging materials provide a barrier to heat transfer during freezing, thus causing foods to freeze in a variable number of hours. In addition, air spaces between the several layers of the packaging material add to the slowness of heat transfer.

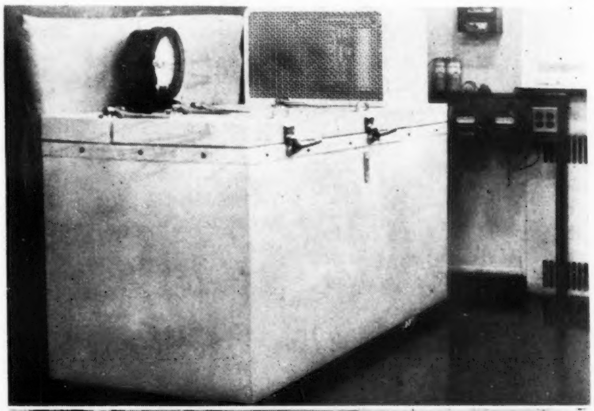
Packaging material which is a barrier to heat transfer during freezing, however, plays a beneficial role in protecting[7] frozen food from possible temperature fluctuations encountered in storage and in normal channels of transportation from the producer to the distributor and finally the consumer.

The purpose of the study was to determine whether moisture losses in foods that have been quick frozen before packaging are sufficiently small to recommend this method of processing. Food freezes before packaging in a matter of minutes as compared in general practice with hours for packaged foods. It is believed that foods thus frozen may retain their original quality for a longer storage period than foods packaged before freezing.

Review of Literature. A review of related literature reveals specific aspects of food freezing on which comparatively little work is reported, particularly on quick freezing of unpackaged food. This field deserves further study and investigation.

Rapid freezing at low temperatures seems to have been recognized early as a fundamental principle in producing a good frozen product. Two general methods emerged in freezing operations, namely comparatively "slow freezing" as applied to fruits, and "quick freezing" as applied to fruits, vegetables, meats, fish and poultry. The definition of "quick freezing" has undergone several modifications since it came into general use.

Quick-frozen products as defined by Birdseye[1] are those which have been frozen by direct immersion in a refrigerant. Quick-frozen products pass quickly through the zone of maximum crystal formation, which occurs during the fall in temperature from 32 to 25 F. Quick freezing means solidification of most of the juices within the cells. Such speed insures very small crystals and a minimum disturbance of tissue structure. Woodroof[8] believed that freezing should pass through the body of the product at 0.03 cm per min or faster. Quick freezing in this study is defined as freezing in which the zone of maximum crystal formation is passed in 30 min or less.



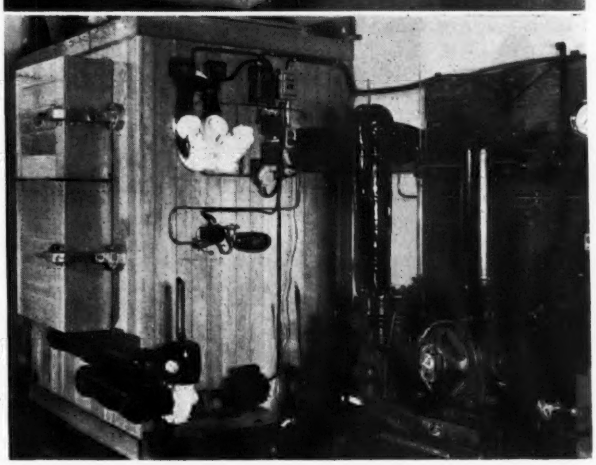


Fig. 1 *(Top)* A well-type domestic frozen-food cabinet used in the study which has a 16-cu-ft capacity, freezing and storage combined • Fig. 2 *(Bottom)* Low-temperature experimental air-blast freezer with three removable shelves built in the air freezer compartment

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at St. Louis, Mo., June, 1946, the Rural Electric Division. Authorized for publication on April 19, 1946, as paper No. 1325 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

J. E. NICHOLAS is professor of agricultural engineering, and GILMA OLSON, GLADYS V. STARR, and THELMA Y. CONES are staff members, department of home economics, Pennsylvania State College.

*Superscript numbers refer to appended references.

Quick freezing may be achieved in three ways: by direct immersion, by indirect freezing with a refrigerant using double-plate contact with packaged products, and by freezing the products unpackaged on freezer plates or in a blast of cold air. The latter method promises to become the most practical in the future. It would seem probable that if it is possible to decrease markedly the freezing time when a product is frozen without packaging, moisture loss also would be minimized[4]. Some retarding influences affecting moisture loss are an exterior shell which exists on some products, the rapid freezing of the enveloping moisture around the individual particles of the product, the quick freezing of the outer coat of the food which acts as an insulator for the interior, and the maintenance of a small temperature difference within the food itself.

Simpson[5] in her study of the performance of well-type domestic cabinets, froze packaged carrots, snap beans, peas, and broccoli in pint boxes. The time required for packaged vegetables to reach 0F, as compared with unpackaged vegetables as determined in the study, is shown in Table 1.

TABLE 1. COMPARISON OF FREEZING RATES OF PACKAGED AND UNPACKAGED VEGETABLES

	Time required to reach 0F, min		
Vegetable	Plate freezer, packaged	Plate freezer, unpackaged	Air-blast freezer, unpackaged
Carrots	370	28.3	16.0
Snap beans	465	50.0	18.5
Broccoli	370	44.0	14.0
Peas	540	42.2	10.0

Problem of Desiccation. Water vapor always moves from a higher pressure to a lower pressure area regardless of whether these conditions occur in the air blast of a freezer or in the cells of frozen or unfrozen food[7]. All food contains water which under lighter air pressure will pass out of the food into the air.

The problem of desiccation divides itself into three phases: desiccation during the preparation of the fresh food, during its freezing period, and during storage of the frozen product. In the preparation stage, the fresh food is in the form which makes it most susceptible to moisture loss. Freshly picked vegetables and fruits usually are warm, soft in texture, their outer coverings are tender, and heat is generated within themselves. This tends to permit the easy flow of moisture from the products. However, with modern equipment products can be quickly cooled, processed and loss minimized. In the first stage of the freezing process, when the temperature of the food is lowered to just below the freezing point and a substantial amount of the latent heat is removed, food may be exposed to its greatest moisture loss. In order to protect the food against excessive moisture loss at this stage, an air-blast freezer must provide large volumes of air containing high relative humidity. The main advantage of the packaged-before-freezing method is in prevention of dehydration from exposure to air, while the main criticism of the air-blast method is that it may result in serious dehydration of loose products during freezing.

Packaging Difficulties after Freezing. Tressler and Evers believed that vegetables such as asparagus and green beans do not lend themselves to loose freezing because of bulkiness and inflexibility in the frozen state. In this study the authors encountered no difficulty in packaging frozen asparagus and green beans, but spinach proved a troublesome product to put into containers. The frozen brittle leaves were crushed and the boxes could not be filled to capacity.

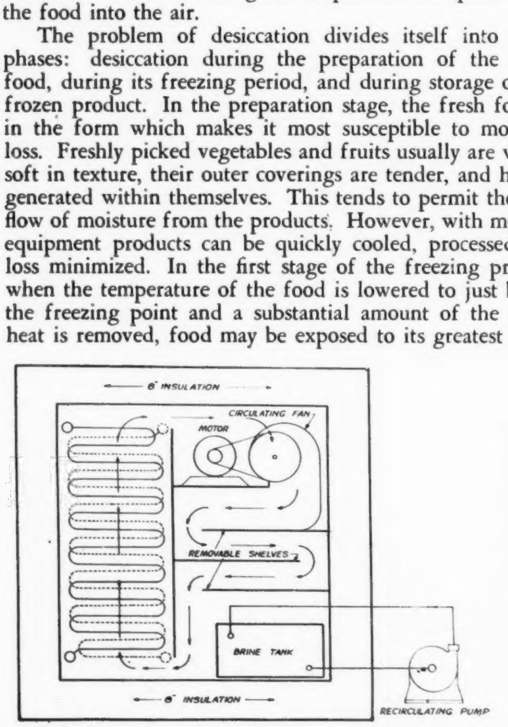
Selection of Vegetables. Vegetables chosen for this study, selected because of their suitability for freezing and their availability on the local market, were carrots, green beans, broccoli, peas, asparagus, beets, and spinach. Only vegetables of the correct maturity for eating fresh were used because the quality of frozen foods is influenced by the quality of the original product. A series of three experiments was run on each vegetable.

Experimental Apparatus and Equipment. Fig. 1 illustrates a 16-cu-ft domestic well-type freezing unit consisting of 4.1-cu-ft freezing compartment and a 11.9-cu-ft storage compartment. It has a 1/3-hp, air-cooled condensing unit using freon as refrigerant. The 16x18½-in bottom plate of the freezing compartment was used as the freezer plate. The evaporator coil is spaced on the reverse side of the freezer plate which provides on the freezing surface an approximate average temperature of −10 F.

Fig. 2 illustrates the experimental air-blast freezer designed principally to provide a wide range of low temperatures in which food may be frozen under different conditions. It consists of an air coil, freezing, and brine tank compartments. The freezing compartment contains three removable shelves arranged 7 in apart so as to permit a continuous air flow, as indicated in Fig. 3. Air temperatures as low as −50 F and as high as +20 F in desirable increments, with or without air motions, are possible.

The temperatures of the air blast, of the freezer plate surface, and of all the products during freezing were obtained with thermocouples made with No. 30 copper-constantan enamel-covered wires.

A 3-gal kettle, containing a convenient wooden rack on which all experimental samples were placed in squares of cheesecloth, was found expedient and satisfactory for steaming products to inactivate enzymes.



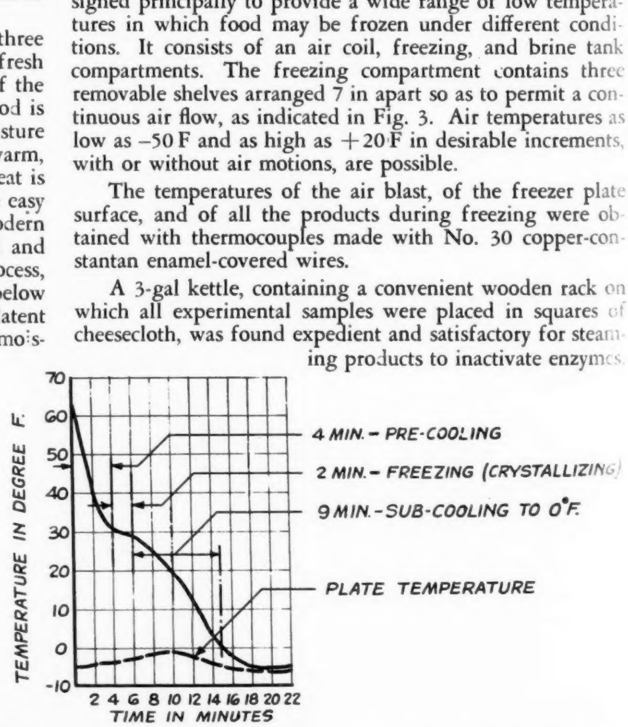


Fig. 3 *(Left)* A cross section of the experimental freezer (Fig. 2) showing position of air freezer coil, freezing compartment with shelves, circulating fan and motor, the brine pump and tank used for immersion freezing experiments • Fig. 4 *(Right)* The speed of freezing of diced carrots on plate freezer, without air motion, illustrating the time in minutes in precooling, freezing and subcooling to 0 F with the average plate temperature approximately —3 F during this interval, for a 1,000-g sample spread one-layer thick

TABLE 2. TIME IN MINUTES FOR UNPACKED VEGETABLES REQUIRED TO PRECOOL, FREEZE, AND SUBCOOL TO 0F WHEN FROZEN ONE-LAYER THICK ON PLATE OF A DOMESTIC WELL-TYPE FREEZER, WITHOUT AIR MOTION

Test series	Product	To precool, min	To freeze, min	To subcool, min	To reach 0F, min	Average zone of crystal formation, min	Average to reach 0F, min	Temp. of freezer plate Initial F	Avg. of test, F
A-1	Carrots	5.0	6.0	16.0	27.0			−8	−1.7
B-1	Carrots	5.5	5.5	17.0	28.0			−5	3.8
C-1	Carrots	8.0	5.0	17.0	30.0	5.5	28.3	−9	−5.3
A-3	Snap beans	7.5	20.0	21.5	49.0			−8	−6.4
B-3	Snap beans	4.0	6.0	30.0	40.0			−8	2.0
C-3	Snap beans	11.0	11.0	39.0	61.0	12.3	50.0	−8	0.0
A-5	Broccoli	12.5	40.0	16.5	69.0			−4	−6.4
B-5	Broccoli	4.5	3.5	10.0	18.0			−4	−6.0
C-5	Broccoli	7.0	16.5	21.5	45.0	16.7	44.0	−11	−6.0
A-7	Peas	12.5	22.5	24.0	59.0			−2	3.1
B-7	Peas	4.5	13.0	9.0	26.5			8	6.6
C-7	Peas	6.5	13.5	7.0	27.0	16.3	37.5	−2	0.1
A-9	Asparagus	8.0	43.5	13.5	56.0			−4	7.0
B-9	Asparagus	13.0	25.0	32.0	70.0			−4	−6.3
C-9	Asparagus	5.5	16.5	27.5	49.5	28.3	58.5	−9	−2.9
A-11	Beets	7.0	7.0	14.0	28.0			−4	6.5
B-11	Beets	7.5	5.0	20.0	32.5			1	5.6
C-11	Beets	4.0	8.5	7.0	19.5	6.8	26.6	−14	12.4
A-13	Spinach	4.0	2.5	11.0	17.5			−8	−7.1
B-13	Spinach	4.0	12.5	15.5	32.0			−10	−5.1
C-13	Spinach	9.0	29.0	39.0	77.0	14.6	42.2	0	−5.8

Preparation of Vegetables. The same general method of preparing the vegetables was employed throughout the study. This method consisted of five steps — cleaning, cutting, steaming, draining, and cooling. The vegetables were washed thoroughly and all inedible portions removed. Broccoli and spinach were allowed to stand in salt water one-half hour, merely to facilitate cleaning. The vegetables were hand-cut as follows: (a) Beets and carrots were diced in approximately ½-in cubes; (b) asparagus and snap beans were cut in ½ to ¾-in lengths; (c) peas were shelled but not sized; (d) spinach was prepared as for table use, and (e) broccoli was similarly prepared.

One thousand grams of each prepared vegetable was weighed, placed in a square piece of cheesecloth, and put in a kettle on a wooden rack for steaming. The kettle contained a quart of rapidly boiling water. The vegetables, with the exception of spinach, were steamed for five minutes to stop enzymatic action; spinach was steamed for two minutes. Joslyn and Cruess[2] recommend blanching with steam in preference to hot water because more of the nutrients in the food are retained. After steaming, the vegetables were removed from the kettle and plunged into ice water in order to prevent further cooking and to chill promptly. As soon as the vegetables were chilled, they were allowed to drain for five minutes and were reweighed to determine the change in weight caused by the steaming and chilling process.

Insertion of Thermocouples. After a vegetable was weighed, thermocouples were inserted into the approximate geometric center of two representative sample pieces. The initial temperatures of the freezing plate measured by a thermocouple which was in direct contact with it, and of the two samples were made and recorded. One of the samples containing a thermocouple was placed in the center of the freezing plate; the second was placed at random, after which the vegetable to be frozen was evenly distributed over the surface of the freezing plate.

In the case of the air-blast freezer, one of the samples containing the thermocouple was placed in the center of the wire tray and the other sample chosen was placed at random. The weighed sample of vegetable was then evenly distributed over the tray. The air-blast temperature was obtained by a standard thermometer and thermocouple, both placed on the middle shelf of the freezer. The fan was on at all times during the freezing trials, except as noted in series tests A-2 and A-12.

Potentiometric Readings. After the initial temperatures of the two samples and of the air or plate were measured and recorded and a vegetable was placed in the freezer, readings were made every minute until the temperature of the product had dropped to 0 F. In the air-blast series, readings on spinach were taken every 30 sec because of the rapid rate of freezing. After the product reached 0 F, it was removed from the freezer and reweighed. Loss of moisture after steaming and after freezing was calculated in terms of the fresh sample. The average per cent moisture loss after steaming and the average per cent moisture loss after freezing were used in calculating the total average per cent moisture loss. After reweighing, the products were packaged, labeled and stored.

Experimental Evidence. The freezing process as illustrated by one of the products (diced carrots) is demonstrated in Fig 4, showing the three phases: precooling, freezing, and subcooling.

Table 2 summarizes the series of three trial tests for each vegetable frozen on the plate of the domestic freezer showing the length of time required in precooling, freezing, and subcooling to 0 F, the total time to reach 0 F, and the initial and average plate temperatures for the respective tests and product.

Table 3 gives similar data for the air-blast freezing of the equivalent series of products.

TABLE 3. TIME IN MINUTES FOR UNPACKAGED VEGETABLES REQUIRED TO PRECOOL, FREEZE, AND SUBCOOL TO 0F WHEN FROZEN ONE-LAYER THICK ON SCREEN TRAY IN AN AIR BLAST AT TEMPERATURES INDICATED

Test series	Product	To precool, min	To freeze, min	To subcool, min	To reach 0F, min	Average zone of crystal formation, min	Average to reach 0F, min	Temp. of freezer plate Initial F	Avg. of test, F
A-2*	Carrots	8.0	7.0	4.0	19.0			−14.0	−10.0
B-2	Carrots	3.5	4.5	7.5	15.5			−8.0	−8.0
C-2	Carrots	2.5	3.5	7.5	13.5	5.3	16.0	+3.1	−7.0
A-4	Snap beans	4.0	14.0	9.5	27.5			+7.5	+9.0
B-4	Snap beans	5.0	9.0	2.0	16.0			+2.1	−5.0
C-4	Snap beans	1.0	4.0	7.0	12.0	9.0	18.5	−14.6	−6.0
A-6	Broccoli	3.5	4.5	12.5	20.5			−12.0	−12.0
B-6	Broccoli	4.0	6.5	3.0	13.5			−14.1	−9.6
C-6	Broccoli	3.5	1.5	3.0	8.0	4.1	14.0	−18.6	−13.7
A-8	Peas	1.0	7.0	3.5	11.5			−10.3	−13.3
B-8	Peas	3.0	6.5	2.5	12.0			−22.4	−13.2
C-8	Peas	1.5	4.0	1.5	7.0	5.8	10.0	−16.6	−15.9
A-10	Asparagus	5.0	5.5	10.0	20.5			−10.0	−9.4
B-10	Asparagus	6.0	9.5	5.0	20.5			−16.0	−10.1
C-10	Asparagus	5.0	9.0	5.5	19.5	8.0	20.1	−10.5	−6.0
A-12	Beets	3.0	8.0	5.0	16.0			−4.2	−12.9
B-12	Beets	2.5	7.5	5.0	15.0			−9.0	−11.0
C-12†	Beets	16.0	8.0	6.0	30.0	7.8	20.3	−10.8	−15.7
A-14	Spinach	1.0	4.5	7.5	13.0			−1.0	−2.0
B-14	Spinach	5.0	2.0	3.0	5.5			−12.0	−11.0
C-14	Spinach	5.0	2.5	3.5	6.5	3.0	8.3	−13.6	−12.4

* Fan off 10 min.
† Fan off 20 min.

lift them at the ends of the field and keep the tractor in balance. With some rough sketches and the preliminary computations out of the way, the owner went back to his own machine shop and proceeded to build the machine. The onions were about five inches high and the weeds were as high or higher before the machine was finally rolled out of the shed and taken to the field. After a half hour of adjustment the machine travelled down the rows of onions doing a perfect job of tilling nine rows at a time. It was possible for one man to till all of the onions, and the machine did such a thorough job that it was necessary for him to till only twice during the first season. The narrow row of undisturbed earth on which the onions were grown was very easy to weed out as the weeds did not need to be pulled but were simply pushed out of position. The rotary tiller cut down about 1½ to 2 in on each side of this rib of undisturbed earth. As a result, the 45 laborers were able to keep the onions clean.

Engineering Farm Safety

(Continued from page 254)

When millions of people and years of tradition are involved this is a long, tedious task particularly where immediate personal incentives are not obvious. With only one weapon many educational leaders may become discouraged before they reach desirable goals. To assure success they should be able to offer more than simply "be careful."

An outstanding example of what can be accomplished in one type of engineering revision is provided by the agricultural engineers who standardized tractor power take-offs and provided uniform shielding. This not only facilitated farm safety, but it led to economy in manufacturing and distribution, as well as convenience to the farmer by reducing the number of parts and hitches. Efforts are now being directed to the development of a telescoping shield that cannot be completely detached from the power drive.

There are hundreds of other farm jobs that need the same type of treatment. The job of erecting ensilage cutter spouts will serve as an example. Can this job be eliminated by making the spout a part of the silo, or will it be necessary to equip silos with well-designed ladders and platforms so the spout can be erected with a reasonable degree of safety? Present methods and facilities are generally hazardous and inconvenient. The daily job of climbing silos during the feeding season also needs investigation. The method of hanging tobacco in drying sheds needs analysis for the purpose of reducing fall hazards and improving efficiency. Even the conventional method of getting into haylofts of ordinary barns deserves attention. Well over half the barn ladders now in use are fall traps. Such things as entrance porches, stairways, storage facilities for household equipment and lighting needs attention in farm homes. Methods of servicing and operating all types of farm equipment such as corn pickers, mowers, combines, tractors and circular saws fall in the same category. These are just a few random examples; they may not even cover the most important ones. Local analysis of accident statistics will uncover an endless list of farm jobs that need consideration in each state or community.

Safety must be designed into every-day farm work and living the same as it is designed into modern factories, automobiles and highways. Accident prevention must be completely dovetailed into farming operations so it is readily acceptable as a part of the job. Actual accomplishments will be limited or retarded where safety is treated as an independent or separate activity. Any engineer who can coordinate safety with efficient production will win acclaim.

Engineering revision of job procedures, structures and equipment is so vital in farm safety that it can determine the success and failure of the whole farm safety movement. Agricultural engineers have the know-how if they elect to apply it. There is no other group in as favorable a position to contribute supporting safety practices and techniques or initiate necessary research.

Like other new fields farm safety lacks development, recognition and professional prestige. Safety offered the same unattractive elements for engineers in the industrial field 30 years ago. Today industrial safety ranks with other recognized branches of the engineering profession and thousands of specialists are now employed in this field. Many hold high executive positions. Is there any reason why farm safety cannot develop in the same manner? The field in agriculture is large; the need is great and momentum is building up. What else is required?

Will agricultural engineers and other subject-matter specialists be willing to swing far enough from established endeavors to absorb this new challenge adequately? If the established subject-matter specialists in agriculture continue to let safety slip by, a new group of specialists is bound to spring up in the agricultural field — farm safety specialists. An unfilled demand will not wait even though other projects are competing for attention. Signposts already indicate that the trend toward developing a new group has begun. Is this what we want? Every agricultural engineer should be concerned and establish the engineering phase of this program before it is too late.

Pioneering in the new field of agricultural education and research, these state farm safety specialists—the first full-time specialists at a national farm safety meeting—met at the office of the National Safety Council on May 1st to discuss their mutual problems and state safety programs. They are left to right: F. R. Willsey, Indiana; W. E. Stuckey, Ohio; Miss K. M. Olmsted, New York; F. W. Roth, Michigan, and R. C. Swanson, Wisconsin

Self-Propelled Combines to Open Grain Fields

By C. E. Everett
MEMBER A.S.A.E.

ONE has only to read the newspapers to realize that the war has not yet been won, for famine, the ugly aftermath of war, threatens to destroy much for which we have fought. The simple fact is that there is not enough food for America to live according to its customary high standards and to take care of the hungry hundreds of millions in Europe and Asia as well.

Much of World on Starvation Diet. Nutritionists tell us that the average human being needs 2650 calories daily to keep alive and healthy. Here in the United States, we get about 3300 calories. In Europe they are getting a bare 1500 calories. With shipments of food to Europe falling far below the absolute requirements, it is up to every one of us to do everything possible to bolster that supply, and at the same time maintain an adequate dinner table for our own people as well.

Of the more important food and feed grains that can be combined, including soybeans and grain sorghums, about 152 million acres have been planted this year, compared to about 138 million acres of the same crops harvested last year. However, last year, with favorable weather, we produced a near record crop. This year, unfortunately, there is grave danger of drought taking its toll, at a time when we can least afford to lose a single planted acre.

But there is one practicable way in which we can add to the stockpile of grain from the coming harvest.

In this country a very large percentage of the small grain is harvested with combines. Almost all of those machines now in use are tractor drawn. A few thousand, perhaps 8,000 out of the total of several hundred thousand, are self-propelled,

Saving Grain On Opening Round. In one forty-acre field, any other shape than a perfect square, a combine travels about 1¼ miles in making the first cut around the outer perimeter of the field. When this combine is one of the conventional type, pulled by a tractor, most of the growing wheat in a path about 8 ft wide, all around the field, is trampled down under the tractor and combine. Most of that wheat is lost. On the other hand, if this first round of 1¼ miles is cut by a self-propelled combine, the wheat will be saved. In an average wheat yield in this 40-acre field, there would be about 20 bu of wheat put into the bin with the self-propelled combine, that the tractor-pulled type would have left on the field.

The 1946 crop in the United States of wheat, barley, oats, rye, rice, and edible beans will be harvested from about 120 million acres. Combines of some kind will travel almost four million miles opening up these fields, and if all could be opened by self-propelled combines, of any make, it would be possible to save 60 million bushels of these grains that would otherwise be tramped down by tractors and pull-type combines!

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

C. E. EVERETT is general consulting engineer, The Massey-Harris Co.

It is only fair to say that even with this loss, which amounts to about two per cent of the crop harvested, combining is still the most efficient way to harvest small grains mechanically. Still, in this emergency and with the critical need for every pound of food that can be provided, it would be sad indeed if, knowing some of this grain can be saved, we who can do something about it would fail to do our utmost to save it.

Every Bushel Means a Day's Bread for 150. If all of the wheat fields in the United States were opened by self-propelled combines, we would recover 32,370,000 bu that would otherwise be wasted, enough wheat to provide a minimum UNRRA bread ration for every man, woman and child in the United States for five weeks. This crop is out in the fields now. Harvest is already in full swing. No one can possibly expect to save all of this waste. But surely we should make an effort to save what we can, and in a sense create food for hungry humans who otherwise might not eat.

Unfortunately there are not enough self-propelled combines in existence to open all the fields. If, however, the 8,000 available self-propelled combines of all makes were to go into the 1946 harvest specializing in the opening of fields and letting the conventional combines cut out the centers, a very large contribution of grain could be made to the famine-stricken world. We have a plan to accomplish that result and we have called its participants "Famine-Fighters."

Famine-Fighter Plan. Through the organized "Famine-Fighters" program it is our plan to bring to every self-propelled combine owner in this country the realization that, by opening every possible field of grain, he will be helping to create loaves of bread that otherwise just would not and could not exist. We are using every means to get this story before the grain farmers of the country. We believe this plan will appeal to any practical farmer because he can understand it.

This picture shows the opening round in a field of grain being made with a Massey-Harris self-propelled combine

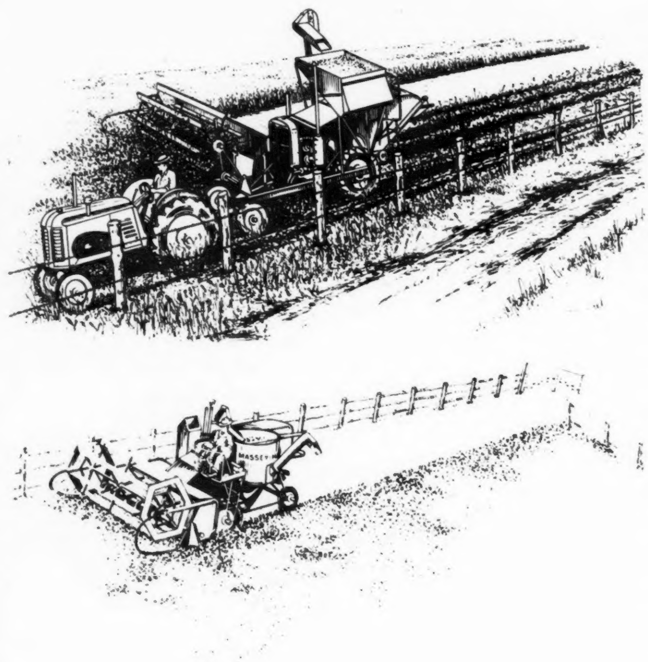
Here is how the "Famine-Fighter" program works: Farm implement dealers are being asked to contact the owners of self-propelled combines and personally present the plan. At the same time they secure the owner's pledge to open 200 extra miles of fields in 1946. Dealers also make available to farmers a list of the self-propelled combine owners who will cooperate in their vicinity.

Self-propelled combine owners indicate their willingness to cooperate by signing the

following pledge: "Realizing the urgent need for food to feed a war-torn world, and knowing as well that starving peoples must look to our nation for help, I pledge wholeheartedly to do my share towards saving every possible bushel of grain during the 1946 harvest season. I will use my self-propelled combine to the greatest possible extent in opening up fields because I know I can save vitally needed grain that would otherwise be trampled into the ground."

Dealers have been sent a supply of posters with the request that they personally attend to hanging these posters in their own stores, in banks, grain elevators, anywhere farmers congregate. Dealers were also supplied with a small booklet for wide distribution to people in the farming communities who see and talk to farmers. These posters and booklets are not advertising pieces; they simply tell the story of saving grain and "creating" food.

Through the farm press and advertising, farmers are being urged to contact self-propelled combine owners and arrange to have their fields opened. After the opening round has been made, farmers will be asked to finish the harvest with their own tractor-drawn combines, so that the self-propelled combines will be able to make their maximum contribution to the food supply by opening other fields rather than handling all of the harvest. If the job is done, farmers will recover $30,000,000 worth of grain which would otherwise be lost, and more important, recover 28,000,000 bushels of grain for the starving peoples of the world.



In the opening round of a grain field, the wheels of the tractor and pull-type combine, shown in the top view, will trample down over 50 per cent of the grain, which will be lost beyond recovery, but by using a self-propelled combine, as in the lower view, all the grain will be cut and saved

"Engineering's Economic Environment"

TO THE EDITOR:

REFERRING to the editorial, entitled "Engineering's Economic Environment" in AGRICULTURAL ENGINEERING for April, it is gratifying to see some interest taken in the problems arising from abundant production. Considering only your final question: "Should engineers explore more thoroughly the economic environment in which they and their developments must operate," it seems clear that the answer must be: "Yes, but with the cooperation of interested economists."

Engineering as a profession is intricately involved with costs and profits. In fact, the economic parameter is the main distinguishing feature between engineering and applied physics. Thus economic study is a province of engineers. There is real need for the cooperation of economists, however, in studying problems of abundance, because this involves the interaction of agriculture with the entire national industry. It is recognized that agriculture is already endowed with surplus resources (as indicated by the nearly steady decline in agriculture ratio).

The piecemeal response in our economic system to imposition of controls on shipment of produce is well understood by agricultural economists. So it should be possible for some specialists to extrapolate to the prospective condition of general surplus production, and to determine just what controls are necessary to turn the zero-profit tendency toward a real achievement of abundance.

If producer cooperatives are a valid approach to the problem of handling abundant production, maybe we need also the cooperation of applied psychologists, in that the success in price maintenance by producer dumping offers higher per acre profits to non-dumping minority non-cooperators. The latter get moral support from public disapproval of dumping.

F. A. BROOKS

Cooperation in Research

(Continued from page 251)

appetizing morsels of information. This is one of the most constructive of human activities.

Applied science, which pays the check, is a different activity and demands a different research technique. It demands a meeting of minds to weigh and analyze the problems of the field toward the solution of which science might contribute. It demands analysis of the sciences involved, the state of progress, and the specific data needed and not yet made available or in prospect through other applied or pure science research. It demands a coordinated, efficient procedure to get the specific needed facts not otherwise available. It requires that the facts obtained be made readily available to all interested persons and interpreted into application data, materials, equipment, designs, use methods or whatever may be necessary to get them applied. An applied science research project is not fully completed until the data produced is applied to the fullest toward solution of the specific problem for which it was sought.

In agricultural engineering this implies that the industries, farmers, and public service agencies concerned work together from the selection and planning of projects until the farmer feels the weight of the extra dollar in his pocket. The examples cited may well be copied in this and other fields.

Moisture Losses of Vegetables During Steaming, Quick Freezing and Packaging

By John E. Nicholas, Gilma Olson, Gladys V. Starr, and Thelma Y. Cones
MEMBER A.S.A.E.

RECENT trends in frozen food storage indicate advantages in freezing before packaging, particularly where large quantities are processed. The ultimate goal is a product which will retain its attractiveness, its palatability, and its nutritive value until consumed. One of the principal functions of packaging is to preserve quality. The general practice has been to freeze food in packages, but the turnover of frozen foods has been rapid and the over-all requirements of packages have not been determined. If foods are to be first frozen and then packaged, it may be necessary to incorporate different characteristics into packages to meet successfully the requirements imposed by this new technique.

During the freezing process a product passes through three definite stages in the low-temperature environment. The first stage, precooling, ranges from the initial temperature to 31 F (degrees Fahrenheit). The second, freezing, is the time during which solidification or maximum crystallization of the moisture content in the product takes place, and is commonly referred to as the "zone of maximum crystal formation". Temperatures during this interval remain relatively constant and range from 31 to 25 F. In the third stage the product is subcooled from 25 to 0 F.

The most significant observation heretofore recorded[3*] is that packaging materials provide a barrier to heat transfer during freezing, thus causing foods to freeze in a variable number of hours. In addition, air spaces between the several layers of the packaging material add to the slowness of heat transfer.

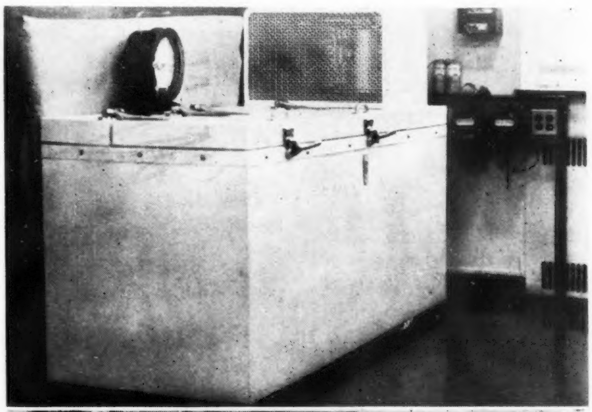
Packaging material which is a barrier to heat transfer during freezing, however, plays a beneficial role in protecting[7] frozen food from possible temperature fluctuations encountered in storage and in normal channels of transportation from the producer to the distributor and finally the consumer.

The purpose of the study was to determine whether moisture losses in foods that have been quick frozen before packaging are sufficiently small to recommend this method of processing. Food freezes before packaging in a matter of minutes as compared in general practice with hours for packaged foods. It is believed that foods thus frozen may retain their original quality for a longer storage period than foods packaged before freezing.

Review of Literature. A review of related literature reveals specific aspects of food freezing on which comparatively little work is reported, particularly on quick freezing of unpackaged food. This field deserves further study and investigation.

Rapid freezing at low temperatures seems to have been recognized early as a fundamental principle in producing a good frozen product. Two general methods emerged in freezing operations, namely comparatively "slow freezing" as applied to fruits, and "quick freezing" as applied to fruits, vegetables, meats, fish and poultry. The definition of "quick freezing" has undergone several modifications since it came into general use.

Quick-frozen products as defined by Birdseye[1] are those which have been frozen by direct immersion in a refrigerant. Quick-frozen products pass quickly through the zone of maximum crystal formation, which occurs during the fall in temperature from 32 to 25 F. Quick freezing means solidification of most of the juices within the cells. Such speed insures very small crystals and a minimum disturbance of tissue structure. Woodroof[8] believed that freezing should pass through the body of the product at 0.03 cm per min or faster. Quick freezing in this study is defined as freezing in which the zone of maximum crystal formation is passed in 30 min or less.



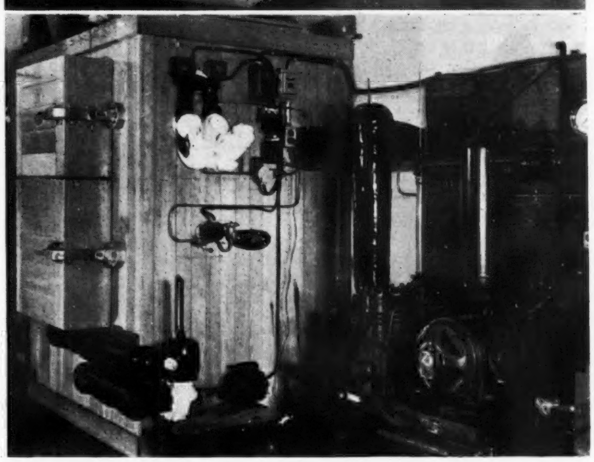


Fig. 1 *(Top)* A well-type domestic frozen-food cabinet used in the study which has a 16-cu-ft capacity, freezing and storage combined • Fig. 2 *(Bottom)* Low-temperature experimental air-blast freezer with three removable shelves built in the air freezer compartment

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*Superscript numbers refer to appended references.

Quick freezing may be achieved in three ways: by direct immersion, by indirect freezing with a refrigerant using double-plate contact with packaged products, and by freezing the products unpackaged on freezer plates or in a blast of cold air. The latter method promises to become the most practical in the future. It would seem probable that if it is possible to decrease markedly the freezing time when a product is frozen without packaging, moisture loss also would be minimized[4]. Some retarding influences affecting moisture loss are an exterior shell which exists on some products, the rapid freezing of the enveloping moisture around the individual particles of the product, the quick freezing of the outer coat of the food which acts as an insulator for the interior, and the maintenance of a small temperature difference within the food itself.

Simpson[5] in her study of the performance of well-type domestic cabinets, froze packaged carrots, snap beans, peas, and broccoli in pint boxes. The time required for packaged vegetables to reach 0 F, as compared with unpackaged vegetables as determined in the study, is shown in Table 1.

TABLE 1. COMPARISON OF FREEZING RATES OF PACKAGED AND UNPACKAGED VEGETABLES

	Time required to reach 0F, min		
Vegetable	Plate freezer, packaged	Plate freezer, unpackaged	Air-blast freezer, unpackaged
Carrots	370	28.3	16.0
Snap beans	465	50.0	18.5
Broccoli	370	44.0	14.0
Peas	540	42.2	10.0

Problem of Desiccation. Water vapor always moves from a higher pressure to a lower pressure area regardless of whether these conditions occur in the air blast of a freezer or in the cells of frozen or unfrozen food[7]. All food contains water which under lighter air pressure will pass out of the food into the air.

The problem of desiccation divides itself into three phases: desiccation during the preparation of the fresh food, during its freezing period, and during storage of the frozen product. In the preparation stage, the fresh food is in the form which makes it most susceptible to moisture loss. Freshly picked vegetables and fruits usually are warm, soft in texture, their outer coverings are tender, and heat is generated within themselves. This tends to permit the easy flow of moisture from the products. However, with modern equipment products can be quickly cooled, processed and loss minimized. In the first stage of the freezing process, when the temperature of the food is lowered to just below the freezing point and a substantial amount of the latent heat is removed, food may be exposed to its greatest moisture loss. In order to protect the food against excessive moisture loss at this stage, an air-blast freezer must provide large volumes of air containing high relative humidity. The main advantage of the packaged-before-freezing method is in prevention of dehydration from exposure to air, while the main criticism of the air-blast method is that it may result in serious dehydration of loose products during freezing.

Packaging Difficulties after Freezing. Tressler and Evers believed that vegetables such as asparagus and green beans do not lend themselves to loose freezing because of bulkiness and inflexibility in the frozen state. In this study the authors encountered no difficulty in packaging frozen asparagus and green beans, but spinach proved a troublesome product to put into containers. The frozen brittle leaves were crushed and the boxes could not be filled to capacity.

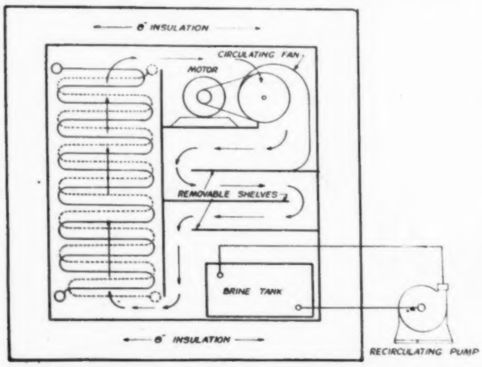
Selection of Vegetables. Vegetables chosen for this study, selected because of their suitability for freezing and their availability on the local market, were carrots, green beans, broccoli, peas, asparagus, beets, and spinach. Only vegetables of the correct maturity for eating fresh were used because the quality of frozen foods is influenced by the quality of the original product. A series of three experiments was run on each vegetable.

Experimental Apparatus and Equipment. Fig. 1 illustrates a 16-cu-ft domestic well-type freezing unit consisting of 4.1-cu-ft freezing compartment and a 11.9-cu-ft storage compartment. It has a 1/3-hp, air-cooled condensing unit using freon as refrigerant. The 16x18½-in bottom plate of the freezing compartment was used as the freezer plate. The evaporator coil is spaced on the reverse side of the freezer plate which provides on the freezing surface an approximate average temperature of −10 F.

Fig. 2 illustrates the experimental air-blast freezer designed principally to provide a wide range of low temperatures in which food may be frozen under different conditions. It consists of an air coil, freezing, and brine tank compartments. The freezing compartment contains three removable shelves arranged 7 in apart so as to permit a continuous air flow, as indicated in Fig. 3. Air temperatures as low as −50 F and as high as +20 F in desirable increments, with or without air motions, are possible.

The temperatures of the air blast, of the freezer plate surface, and of all the products during freezing were obtained with thermocouples made with No. 30 copper-constantan enamel-covered wires.

A 3-gal kettle, containing a convenient wooden rack on which all experimental samples were placed in squares of cheesecloth, was found expedient and satisfactory for steaming products to inactivate enzymes.



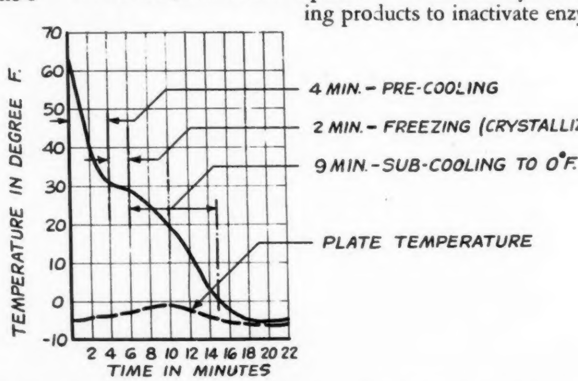


Fig. 3 *(Left)* A cross section of the experimental freezer (Fig. 2) showing position of air freezer coil, freezing compartment with shelves, circulating fan and motor, the brine pump and tank used for immersion freezing experiments • Fig. 4 *(Right)* The speed of freezing of diced carrots on plate freezer, without air motion, illustrating the time in minutes in precooling, freezing and subcooling to 0 F with the average plate temperature approximately —3 F during this interval, for a 1,000-g sample spread one-layer thick

TABLE 2. TIME IN MINUTES FOR UNPACKED VEGETABLES REQUIRED TO PRECOOL, FREEZE, AND SUBCOOL TO 0F WHEN FROZEN ONE-LAYER THICK ON PLATE OF A DOMESTIC WELL-TYPE FREEZER, WITHOUT AIR MOTION

Test series	Product	To precool, min	To freeze, min	To subcool, min	To reach 0F, min	Average zone of crystal formation, min	Average to reach 0F, min	Temp. of freezer plate Initial F	Avg. of test, F
A-1	Carrots	5.0	6.0	16.0	27.0			—8	—1.7
B-1	Carrots	5.5	5.5	17.0	28.0			—5	3.8
C-1	Carrots	8.0	5.0	17.0	30.0	5.5	28.3	—9	—5.3
A-3	Snap beans	7.5	20.0	21.5	49.0			—8	—6 4
B-3	Snap beans	4.0	6.0	30.0	40.0			—8	2.0
C-3	Snap beans	11.0	11.0	33.0	61.0	12.3	50.0	—8	0.0
A-5	Broccoli	12.5	40.0	16.5	69.0			—4	—6.4
B-5	Broccoli	4.5	3.5	10.0	18.0			—4	—6.0
C-5	Broccoli	7.0	16.5	21.5	45.0	16.7	44.0	—11	—6.0
A-7	Peas	12.5	22.5	24.0	59.0			—2	3.1
B-7	Peas	4.5	13.0	9.0	26.5			8	6.6
C-7	Peas	6.5	13.5	7.0	27.0	16.3	37.5	—2	0.1
A-9	Asparagus	8.0	43.5	13.5	56.0			—4	7.0
B-9	Asparagus	13.0	25.0	32.0	70.0			—4	—6.3
C-9	Asparagus	5.5	16.5	27.5	49.5	28.3	58.5	—9	—2.9
A-11	Beets	7.0	7.0	14.0	28.0			—4	6.5
B-11	Beets	7.5	5.0	20.0	32.5			1	5.6
C-11	Beets	4.0	8.5	7.0	19.5	6.8	26.6	—14	12.4
A-13	Spinach	4.0	2.5	11.0	17.5			—8	—7.1
B-13	Spinach	4.0	12.5	15.5	32.0			—10	—5.1
C-13	Spinach	9.0	29.0	39.0	77.0	14.6	42.2	0	—5.8

Preparation of Vegetables. The same general method of preparing the vegetables was employed throughout the study. This method consisted of five steps — cleaning, cutting, steaming, draining, and cooling. The vegetables were washed thoroughly and all inedible portions removed. Broccoli and spinach were allowed to stand in salt water one-half hour, merely to facilitate cleaning. The vegetables were hand-cut as follows: (a) Beets and carrots were diced in approximately ½-in cubes; (b) asparagus and snap beans were cut in ½ to ¾-in lengths; (c) peas were shelled but not sized; (d) spinach was prepared as for table use, and (e) broccoli was similarly prepared.

One thousand grams of each prepared vegetable was weighed, placed in a square piece of cheesecloth, and put in a kettle on a wooden rack for steaming. The kettle contained a quart of rapidly boiling water. The vegetables, with the exception of spinach, were steamed for five minutes to stop enzymatic action; spinach was steamed for two minutes. Joslyn and Cruess[2] recommend blanching with steam in preference to hot water because more of the nutrients in the food are retained. After steaming, the vegetables were removed from the kettle and plunged into ice water in order to prevent further cooking and to chill promptly. As soon as the vegetables were chilled, they were allowed to drain for five minutes and were reweighed to determine the change in weight caused by the steaming and chilling process.

Insertion of Thermocouples. After a vegetable was weighed, thermocouples were inserted into the approximate geometric center of two representative sample pieces. The initial temperatures of the freezing plate measured by a thermocouple which was in direct contact with it, and of the two samples were made and recorded. One of the samples containing a thermocouple was placed in the center of the freezing plate; the second was placed at random, after which the vegetable to be frozen was evenly distributed over the surface of the freezing plate.

In the case of the air-blast freezer, one of the samples containing the thermocouple was placed in the center of the wire tray and the other sample chosen was placed at random. The weighed sample of vegetable was then evenly distributed over the tray. The air-blast temperature was obtained by a standard thermometer and thermocouple, both placed on the middle shelf of the freezer. The fan was on at all times during the freezing trials, except as noted in series tests A-2 and A-12.

Potentiometric Readings. After the initial temperatures of the two samples and of the air or plate were measured and recorded and a vegetable was placed in the freezer, readings were made every minute until the temperature of the product had dropped to 0 F. In the air-blast series, readings on spinach were taken every 30 sec because of the rapid rate of freezing. After the product reached 0 F, it was removed from the freezer and reweighed. Loss of moisture after steaming and after freezing was calculated in terms of the fresh sample. The average per cent moisture loss after steaming and the average per cent moisture loss after freezing were used in calculating the total average per cent moisture loss. After reweighing, the products were packaged, labeled and stored.

Experimental Evidence. The freezing process as illustrated by one of the products (diced carrots) is demonstrated in Fig 4, showing the three phases: precooling, freezing, and subcooling.

Table 2 summarizes the series of three trial tests for each vegetable frozen on the plate of the domestic freezer showing the length of time required in precooling, freezing, and subcooling to 0 F, the total time to reach 0 F, and the initial and average plate temperatures for the respective tests and product.

Table 3 gives similar data for the air-blast freezing of the equivalent series of products.

TABLE 3. TIME IN MINUTES FOR UNPACKAGED VEGETABLES REQUIRED TO PRECOOL, FREEZE, AND SUBCOOL TO 0F WHEN FROZEN ONE-LAYER THICK ON SCREEN TRAY IN AN AIR BLAST AT TEMPERATURES INDICATED

Test series	Product	To precool, min	To freeze, min	To subcool, min	To reach 0F, min	Average zone of crystal formation, min	Average to reach 0F, min	Temp. of freezer plate Initial F	Avg. of test, F
A-2*	Carrots	8.0	7.0	4.0	19.0			—14.0	—10.0
B-2	Carrots	3.5	4.5	7.5	15.5			—8.0	—8.0
C-2	Carrots	2.5	3.5	7.5	13.5	5.3	16.0	+3.1	—7.0
A-4	Snap beans	4.0	14.0	9.5	27.5			+7.5	+9.0
B-4	Snap beans	5.0	9.0	2.0	16.0			+2.1	—5.0
C-4	Snap beans	1.0	4.0	7.0	12.0	9.0	18.5	—14.6	—6.0
A-6	Broccoli	3.5	4.5	12.5	20.5			—12.0	—12.0
B-6	Broccoli	4.0	6.5	3.0	13.5			—14.1	—9.6
C-6	Broccoli	3.5	1.5	3.0	8.0	4.1	14.0	—18.6	—13.7
A-8	Peas	1.0	7.0	3.5	11.5			—10.3	—13.3
B-8	Peas	3.0	6.5	2.5	12.0			—22.4	—13.2
C-8	Peas	1.5	4.0	1.5	7.0	5.8	10.0	—16.6	—15.9
A-10	Asparagus	5.0	5.5	10.0	20.5			—10.0	—9.4
B-10	Asparagus	6.0	9.5	5.0	20.5			—16.0	—10.1
C-10	Asparagus	5.0	9.0	5.5	19.5	8.0	20.1	—10.5	—6.0
A-12	Beets	3.0	8.0	5.0	16.0			—4.2	—12.9
B-12	Beets	2.5	7.5	5.0	15.0			—9.0	—11.0
C-12†	Beets	16.0	8.0	6.0	30.0	7.8	20.3	—10.8	—15.7
A-14	Spinach	1.0	4.5	7.5	13.0			—1.0	—2.0
B-14	Spinach	5.0	2.0	3.0	5.5			—12.0	—11.0
C-14	Spinach	5.0	2.5	3.5	6.5	3.0	8.3	—13.6	—12.4

* Fan off 10 min.
† Fan off 20 min.

Air-Temperature Variations and Freezing Rates of Unpackaged Vegetables in Air Blast. The average air temperature of the blast freezer in these experiments ranged from 9 F (test A-4) to –15.9 F (test C-8) (Table 3), or an average of –9.3 F for the 21 trials. The corresponding range in plate temperatures for the 21 trials was from 12.4 to –7.1 F, or an average of –0.52 F (Table 2). A high average air-blast temperature of 9 F (test A-4) prolonged the freezing time of the product. The temperature difference between the "on" and "off" period of the cycle in the air-blast freezer is about 2 or 3 deg. Since food was not always placed in the freezer compartment at the same part of the cycle, this accounts, in part, for the air-temperature variations, which were also influenced by the length of time the door of the freezer compartment was held open when the food was placed in the freezer.

Due to an experimental error in series A-2 and C-12, in which the air circulating fan was not in operation until 10 and 20 min respectively, after the beginning of the experiments, no profound change was noted in the per cent moisture variation during freezing. However, the time of freezing was prolonged.

The average time required for the products to pass through the "zone of maximum crystal formation" with air blast varied with the vegetable. The average minimum length of time required was 3 min for spinach (Table 3). The maximum length of time required was 9 min for green beans. Broccoli required 4.1 min, carrots 5.3 min, peas 5.8 min, beets 7.8 min, and asparagus 8.0 min.

Factors Affecting Freezing Rates. Air motion markedly affects the length of the freezing time, specifically the precooling phase (Table 3). The products in the two experiments, in which starting the fan was delayed, took longer to precool than the same products in the other two series. In the first test on carrots, the precooling time was 8.0 min; in the second test, 3.5 min; and in the third test, 2.5 min. Beets in the third test precooled in 16.0 min, in the second test in 2.5 min, and in the first test in 3.0 min. In both instances the fact that the fan was not on throughout the experimental period lengthened the precooling time considerably. Therefore, the total time to reach 0 F was longer than in the other two series of the same experiment. The carrots in series A-2 took 19.0 min to reach 0 F, while in the other two series they took but 15.5 and 13.5 min. Beets exhibited the same general behavior. In series C-12 they took 30 minutes to reach 0 F, while in the other two series they took 15 and 16 min. This indicates that "quick" freezing of certain vegetables may be possible in the air-blast freezer, only if the fan which circulates the air is on continuously.

Other variations in the total time required for vegetables to reach 0 F may be attributed to fluctuations in average air temperature in the freezer during the three tests on a given product. In the case of beans as shown in Table 3, series A-4, when the average temperature of the air was 9 F, it took approximately twice as long for the product to reach 0 F as it did in series C-4 where the average air temperature was –6 F. This also shows that the lower temperatures provide quicker freezing.

Freezing Rates of Unpackaged Vegetables on Plate in Domestic-Type Freezer. The time required by spinach to reach 0 F on the plate of the domestic-type freezer ranged from a minimum of 17.5 min to a maximum of 77 min (Table 2). The possible reasons for this variation in freezing rate within the same vegetable, test series A-13 and C-13 (Table 2) may have resulted from difference in thickness of stem, difference in maturity of representative samples into which the thermocouples were inserted, or the proximity of the plate surface from the freezing product. An attempt was made to select samples of the same degree of maturity, but the range of maturity found in 3000 g of this product was wide and there was no way of assuring absolute accuracy at this point.

The average time required in this test series (Table 2) for the product to reach 0 F was longer for each vegetable than in the series with an air blast to reach this temperature (Table 3).

The average time required for each vegetable to reach 0 F was as follows:

carrots	28.3 min	asparagus	58.5 min
broccoli	44.0 min	beets	26.6 min
peas	37.5 min	spinach	42.2 min
snap beans	50.0 min		

Moisture Variation in the Steaming and Freezing Processes. The original weight of the fresh 1000-g samples as prepared for steaming constituted the basis of calculations in evaluating changes during steaming and freezing.

Tables 4 and 5 show weight details and percentage variations for the series of tests during steaming, and during freezing on plates and in air blast.

Moisture changes during steaming ranged from a gain of 7.2 per cent in broccoli, test series A-5 (Table 4), to a loss of 24.5 per cent in spinach, test series A-14 (Table 5). Snap beans and broccoli gained weight consistently in two of the three series of tests, A, B, and C-3 and A, B, and C-5, respectively. Carrots, broccoli, and peas also gained in steaming in series 2, 6, and 8, respectively. The average gain of 3.23 per cent for peas (Table 5) and the average loss of 1.90 per cent for peas (Table 4) may perhaps be accounted for by differences in state of freshness and of maturity. This factor probably applied equally well to the other vegetables.

The gain in weight during steaming despite the succeeding loss in weight during freezing resulted in a gain

TABLE 4. MOISTURE VARIATIONS OF VEGETABLES AFTER STEAMING AND FREEZING ON PLATE

		Weight in grams			Per cent moisture variations*				
Test series	Product	Initial	After steaming	After freezing	After steaming	Average after steaming	After freezing	Average after freezing	Average of the processes
A-1	Carrots	1000	1048	1024	+4.8		+2.4		
B-1	Carrots	1000	976	930	—2.4		—7.0		
C-1	Carrots	1000	998	977	—0.2	+0.73	—2.3	—2.30	—0.79
A-3	Snap beans	1000	1016	998	+1.6		—0.2		
E-3	Snap beans	1000	1039	1022	+3.9		+2.2		
C-3	Snap beans	1000	1007	979	+0.7	+2.06	—2.1	—0.03	+1.02
A-5	Broccoli	1000	1072	1037	+7.2		+3.7		
B-5	Broccoli	1000	1008	998	+0.8		—0.2		
C-5	Broccoli	1000	1017	1002	+1.7	+3.23	+0.2	+1.23	+2.23
A-7	Peas	1000	992	973	—0.8		—2.7		
B-7	Peas	1000	982	948	—1.8		—5.2		
C-7	Peas	1000	969	950	—3.1	—1.90	—5.0	—4.30	—3.10
A-9	Asparagus	1000	975	957	—2.5		—4.3		
B-9	Asparagus	1000	1010	994	+1.0		—0.6		
C-9	Asparagus	1000	1010	991	+1.0	—0.17	—0.9	—1.93	—1.05
A-11	Beets	1000	974	967	—2.6		—3.3		
B-11	Beets	1000	987	980	—1.3		—2.0		
C-11	Beets	1000	956	940	—4 4	—2.77	—6.0	—3.77	—3.27
A-13	Spinach	1000	866	817	—13.4		—18.3		
B-13	Spinach	1000	793	754	—20.7		—24.6		
C-13	Spinach	1000	885	865	—11.5	—15.2	—13.5	—18.80	—17.00

* The plus (+) sign indicates a moisture gain, and the minus (—) sign a moisture loss.

TABLE 5. MOISTURE VARIATIONS OF VEGETABLES AFTER STEAMING AND FREEZING IN AIR BLAST*

Test series	Product	Initial weight, in grams	Weight after steaming, in grams	Per cent moisture variation after steaming	Average per cent moisture variation after steaming	Weight after freezing, in grams	Per cent moisture variation after freezing	Average per cent moisture variation after freezing	Total average per cent moisture variation
A-2	Carrots	1000	1027	+2.7		986	—1.4		
B-2	Carrots	1000	1007	+ .7		966	—3.4		
C-2	Carrots	1000	1040	+4.0	+2.46	1003	+ .3	—1.50	+ .48
A-4	Snap beans	1000	1027	+2.7		998	— .2		
B-4	Snap beans	1000	960	—4.0		942	—5.8		
C-4	Snap beans	1000	1009	+ .9	— .13	987	—1.3	—2.43	—1.28
A-6	Broccoli	1000	1036	+3.6		1001	+ .1		
B-6	Broccoli	1000	1003	+ .3		973	—2.7		
C-6	Broccoli	1000	1017	+1.7	+1.86	1004	+ .4	— .73	+ .57
A-8	Peas	1000	1025	+2.5		1001	+ .1		
B-8	Peas	1000	1043	+4.3		1019	+1.9		
C-8	Peas	1000	1029	+2.9	+3.23	1005	+ .5	+ .83	+2.03
A-10	Asparagus	1000	947	—5.3		933	—6.7		
B-10	Asparagus	1000	974	—2.6		959	—4.1		
C-10	Asparagus	1000	987	—1.3	—3.06	969	—3.1	—4.63	—3.85
A-12	Beets	1000	973	—2.7		930	—7.0		
B-12	Beets	1000	987	—1.3		945	—5.5		
C-12	Beets	1000	987	—1.3	—1.76	946	—5.4	—5.96	—3.86
A-14	Spinach	1000	755	—24.5		720	—28.0		
B-14	Spinach	1000	756	—24.4		727	—27.3		
C-14	Spinach	1000	767	—23.3	—24.06	839	—16.1	—23.80	—23.93

* Moisture loss is represented by a minus (—) sign and moisture gain by a plus (+) sign.

in the final frozen product in series tests 2, carrots; 3, snap beans; 5 and 6, broccoli; and 8, peas. A comparatively large loss in weight occurred in spinach in both series of tests 13 and 14, giving overall average losses of 17.00 and 23.93 per cent at the end of the freezing process.

Table 6 shows the percentage variation of the "even" or air-blast and "odd" or plate series of tests and gives the average of the two series (Tables 4 and 5). In two out of the seven vegetables in the odd or plate freezing series, the total average moisture variation represented gains ranging from 1.02 to 2.23 per cent (Table 4), during steaming and freezing. The loss for beets in this series was 3.27 per cent. In the even or air-blast series, three out of the seven vegetables showed gains ranging from 0.48 to 2.03 per cent. The loss for beets was 3.86 per cent (Table 5), with the maximum average loss for the "even" and "odd" series for spinach, a leafy vegetable, of 20.47 per cent (Table 6).

TABLE 6. PERCENTAGE VARIATIONS OF MOISTURE LOSS IN THE PLATE AND AIR-BLAST FREEZING SERIES AND THEIR AVERAGE

	On plate (odd) per cent	In air blast (even) per cent	Average per cent
Carrots	—0.79	+0.48	—0.16
Snap beans	+1.02	—1.28	—0.13
Broccoli	+2.23	+0.57	+1.40
Peas	—3.10	+2.03	—0.54
Asparagus	—1.05	—3.85	—2.45
Beets	—3.27	—3.86	—3.57
Spinach	—17.00	—23.93	—20.47

There is a great reduction in the time required to freeze unpackaged as compared with that required to freeze packaged vegetables, even on a plate freezer. The time required to reach 0 F was approximately 13 times greater in packaged peas and carrots, 9 times greater in packaged snap beans, spinach, and broccoli than that required for the same vegetables when frozen unpackaged.

When compared to the average time freezing was accomplished by the air-blast method, the reduction is much more significant. It is recognized, however, that the average temperatures of "air blast" and of plate were of the levels -9.3 F and 0.53 F, respectively. This factor should be considered for comparative analysis.

Based on the experimental evidence of this study, it appears that the moisture loss in vegetables during unpackaged freezing is negligible. In fact, the gains in the moisture content of the vegetables during steaming compensated for most of the losses occurring during freezing. The time required to freeze packaged vegetables was greatly reduced by freezing such products in an unpackaged state. Speed is important because it may affect quality. Therefore, unpackaged freezing of such products as lend themselves to packaging after being frozen is desirable.

SUMMARY AND CONCLUSIONS

1 This study was conducted to determine whether moisture losses in products frozen before packaging are small enough to recommend this method of freezing.

2 Vegetables selected for freezing were carrots, green beans, broccoli, peas, asparagus, beets, and spinach. These vegetables were chosen because of their availability on the market and their suitability for freezing.

3 The vegetables purchased from a local market were cleaned thoroughly and all the inedible portions removed. Carrots, beans, asparagus and beets were cut into smaller pieces.

4 The vegetables were steamed in a covered kettle for 5 min, with the exception of spinach which was steamed for 2 min. The steaming process was timed by a stop watch.

5 Per cent moisture variations were determined after steaming and after freezing. Total per cent moisture variations were calculated by algebraically adding per cent moisture variations after steaming and after freezing.

6 Packaging difficulties of the food in the frozen state were encountered only with spinach.

7 Freezing rates of the products frozen before packaging were determined and compared with freezing rates of the same products frozen in packages.

8 Total per cent moisture variations ranged from an average 20.27 per cent moisture loss in spinach to an average 1.40 per cent moisture gain in broccoli (Table 5).

9 Moisture losses in the vegetables quick frozen before packaging were negligible, with the exception of spinach.

10 Gains in moisture content of the vegetables during the steaming and chilling process compensated for any losses occurring in the freezing process.

11 Unpackaged products froze from approximately 9 to 13 times faster on plate at -0.5 F and 23 to 53 times faster in an air blast at -9.3 F than packaged products at approximately equal temperatures.

12 The average time for "zone of maximum crystal formation" for all the vegetables was less than 10 min in air blast freezing and less than 30 min in plate freezing.

13 It was concluded that the method of freezing products before packaging may be recommended for carrots, green beans, broccoli, peas, asparagus, and beets because of the relatively small moisture losses and the great reduction in the time required for freezing. This method was not found satisfactory for spinach because of the difficulty in packaging the frozen product. The high percentage loss for spinach was, however, in steaming and chilling and not in freezing.

14 The average loss for six vegetables (not including spinach) for all series of tests was 0.91 per cent.

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"Application of Stream Gaging to the Agricultural Use of Small Streams and Ponds"

TO THE EDITOR:

IN HIS paper published in AGRICULTURAL ENGINEERING for January, 1946, pages 26 to 28, M. T. Thompson applies the duration-curve method for the determination of reservoir storage for farm ponds. He stresses the fact that actual runoff records provide the most reliable basis for design purposes. Furthermore, it is pointed out that rainfall-runoff relations alone do not provide truly reliable criteria for design.

The writer would like to add emphasis to the need for actual runoff records. He would make these measurements on typical agricultural areas of different size where there are both wet weather and perennial streams. With a few years of such runoff records, he would derive seasonal rainfall-runoff relationships and apply them to long-term (50 years or more) rainfall records. This would provide a synthesized 50-year runoff record by seasons. From this runoff table or mass curve, critical dry periods of different length could be determined. By comparing the runoff values in these drought periods with the evaporation, seepage losses, pond rainfall, and use demands, the minimum allowable drainage area for adequate water supply could be determined for the particular-sized pond.

The writer also desires to take exception to the duration method of determining storage requirements (Fig. 3 of Mr. Thompson's paper). If the same demand of 50 second-feet was used on Fig. 1 as used on Fig. 3, the maximum period of storage, when runoff was less than this rate, would be about 2 months, May and June. The required storage volume is, therefore, about one-third of that shown in Fig. 3. The reason for this is apparent. All of the daily flow less than the demand rate does not occur in a continuous period. Duration curves for a long period of record can not consider this fact. Referring again to Fig. 1, there are many days with runoff rates exceeding the demand rate. Then the pond will be filling. It looks as though the pond may be about full by the end of September.

To take an extreme case, assume the flow rate on odd days to be zero and that on even days to be twice the use demand. According to the duration curve method, storage for half the year would be needed. Actually, only one day's storage would be required.

More than one year's data are needed to determine the storage requirements. With several years of runoff record, the writer would rather use the actual sequence of events than the duration of determining storage requirements.

L. L. HARROLD.

Winter Storage of Vegetables in the Hotbed

By Lawrence C. Porter
FELLOW A.S.A.E.

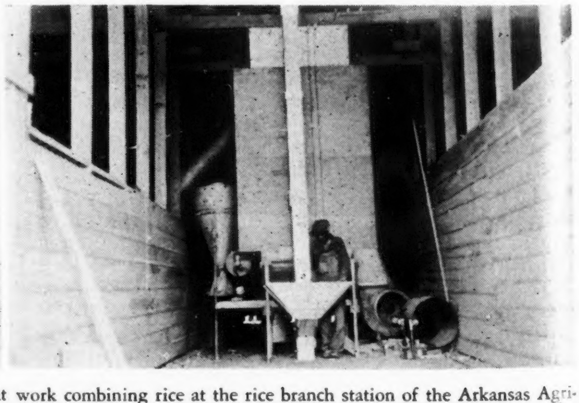
ONE who has a small garden but with no underground root cellar is always up against it for winter storage of some of his produce. Those who have hotbeds may be interested in my experience.

Last fall I placed various garden produce in baskets, set them into my hotbed, and placed about a 6-in layer of leaves between the sides and ends of the hotbed and the vegetables. An old carpet was laid across the top of the vegetables and the thermostat controlling the soil-heating cable set at 35 F. A very small opening was left at the upper end of hotbed for ventilation.

We have already had two spells of zero weather, but the vegetables, with the exception of a few summer squash which molded, are in excellent condition.

This may be a rather expensive method of storing vegetables. Nevertheless the cost of operating the hotbed has been far below what it would have been to purchase the vegetables that have come out of it since last fall.

(EDITOR'S NOTE: Mr. Porter reported the middle of March that he had just taken some beautiful brussels sprouts, broccoli, carrots, and parsnips out of his hotbed. He says they were in excellent condition and both he and his wife thought they tasted better than fresh ones purchased at the store. He says further that his hotbed, with the exception of four months in the summer, has been useful the year round.)



Left: One of the new experimental "light-metal" farm machines at work combining rice at the rice branch station of the Arkansas Agricultural Experiment Station near Stuttgart • *Right:* Experimental portable grain drier developed at Louisiana State University in use for drying oats on a farm near Vicksburg. (Photos by F. Hal Higgins)

Area Relationships That Simplify the Hydrologic Design of Small Farm Ponds

By W. D. Potter and D. B. Krimgold
MEMBER A.S.A.E. MEMBER A.S.A.E.

THE surface areas, the depths, and the volumes of farm ponds or small reservoirs often govern the economic and structural feasibility of such developments. When the drainage area is fixed, these dimensions also determine whether or not the pond or reservoir will fill within a reasonable time, and, if so, whether it will furnish a dependable supply of usable water[1,2*].

The great majority of farm ponds are small. The spillways are usually excavated channels protected by vegetation. Hydrologic considerations[2] indicate that, to keep the flow over the spillways to a minimum, the depth of water, and therefore the size of surface area must fluctuate fairly widely.

The funds usually available for the construction of such ponds are not sufficient to permit elaborate computations or even simple field surveys in individual cases. We therefore found it necessary to resort to some scheme whereby a simple but safe procedure could be developed for use by subprofessional and even non-professional people. This required simplifying assumptions consistent with allowable tolerances. The basic assumption was that, for farm ponds with fluctuating depths of water, the "mean surface area" (the volume of the pond divided by the maximum depth) could be safely used in arriving at capacities and dimensions of ponds and at sizes of drainage areas required to furnish dependable supplies of various amounts of usable water[2].

Small farm ponds usually consist of an excavated and a natural portion, as illustrated in Fig. 1. The volume of the excavated portion can be readily determined from the dimensions of the pit. Except where it is entirely unsuitable, the excavated material is commonly used in constructing a dam or dike which creates additional pondage space above the original natural ground. The problem thus resolved into finding a simple means of determining for various depths the volume of the "natural pondage" which, when added to the excavation and divided by the depth, would give the "mean surface area" of the entire pond.

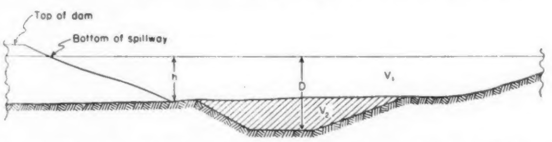


Fig. 1 This drawing shows a section through a typical small farm pond. V_1=volume above natural ground; V_2=volume of excavation; "mean surface area" $= (V_1 + V_2)/D$

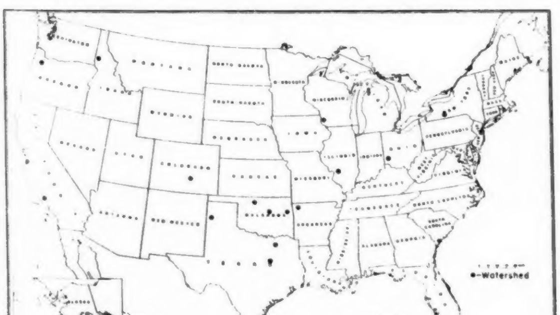


Fig. 2 The map shows location of watersheds selected for the study reported in the accompanying paper

The most satisfactory solution to this problem is a topographic survey of the reservoir site. For many of the smaller ponds, however, such a survey would disproportionately increase the cost of the pond. For these cases it was desirable that a more simple procedure be found.

The first thought was that in a physiographic region with specific land slopes, as well as shapes and slopes of channels peculiar to the region, there should exist a fair

TABLE 1. WATERSHEDS SELECTED FOR STUDY

No.	Location	Size, acres	Contour interval, ft
W IV	Newberg, Ore.	6.2	2
W II	Bentonville, Ark.	9.34	2
W III	Garland, Tex.	10.4	2
W I	Colorado Springs, Colo.	10.63	2
W III	Newberg, Ore.	12.8	2
W I	Newberg, Ore.	13.2	2
W VI	Garland, Tex.	13.6	2
W III	Bentonville, Ark.	14.25	2
W I	Muskogee, Okla.	14.49	2
W II	Hamilton, O.	16.2	2
W 10	Waco, Tex.	19.7	2
Y-6	Waco, Tex.	20.9	2
W III	Vega, Tex.	21.2	4
W II	Fennimore, Wis.	22.8	2
W IV	Bentonville, Ark.	24.0	2
W III	Bath, N. Y.	24.25	5
W IV	Muskogee, Okla.	24.9	2
W III	Watsonville, Cal.	27.4	5
W II	Freehold, N. J.	32.89	2
W III	Colorado Springs, Colo.	35.4	2
W IV	Colorado Springs, Colo.	35.6	2
W II	Colorado Springs, Colo.	39.7	2
Y-7	Waco, Tex.	40.0	2
W-8	Waco, Tex.	40.4	2
W-6	Waco, Tex.	42.3	2
No. 1	Waco, Tex.	47.6	2
W II	Edwardsville, Ill.	49.95	2
Y-4	Waco, Tex.	79.9	2
W-II	Vega, Tex.	95.9	2
W-IV	Freehold, N. J.	102.7	5
W I	Vega, Tex.	129.4	2
Y-2	Waco, Tex.	132.0	2
W I	Moscow, Idaho	146.6	5
W V	Santa Paula, Cal.	162.7	5
W IV	Fennimore, Wis.	171.0	5
W II	Moscow, Idaho	177.9	5
No. 1	Guthrie, Okla.	*	2
No. 2	Guthrie, Okla.	*	2
No. 3	Guthrie, Okla.	*	2
No. 1	Cherokee, Okla.	*	2
	WATERSHEDS LARGER THAN 200 ACRES		
Y	Waco, Tex.	309.	2
Z	Waco, Tex.	310.	2
C	Waco, Tex.	579.	2
D	Waco, Tex.	1110.	2
G	Waco, Tex.	4380.	2
J	Waco, Tex.	5860.	2

*Less than 20 acres.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

W. D. POTTER and D. B. KRIMGOLD are, respectively, hydraulic engineer and soil conservationist, Soil Conservation Service, Research, U. S. Department of Agriculture.

*Superscript numbers refer to appended references.

relationship between depth (height of spillway above natural ground) and volume of the unexcavated portions of reservoirs. It was reasoned that, if such a relationship existed, it would be possible to prepare tables for watersheds of various sizes within each physiographic region. Such tables would show volume above ground for dams of various heights. This was tried but without much success. Having failed in the attempt to obtain what would have been the simplest solution, our next step was to investigate the possibility that a relationship might exist between the surface area of a pond and the "mean surface area."

Forty-six small watersheds, for which detailed topographic maps had been prepared[8], were selected for the investigation. These watersheds ranged in size from 6.2 to 5,860 acres (Table 1) and were located in 12 different states (Fig. 2). Thirty-eight of the maps had a 2-ft contour interval, 7 had an interval of 5 ft, and one of 4 ft. Volumes were determined for depths corresponding to each contour up to 16 ft by the average-end-area method. Dividing each volume by the total depth gave values for the "mean surface area."

Values of "mean surface area" and of surface area at full depth (spillway level) were divided into five groups based upon size of the watersheds. The limiting values of drainage area for these groups were 0-20 acres, 20-50 acres, 50-200 acres, 200-500 acres and 500 acres or greater. For each group, values of "mean surface area" for a depth of 6 ft were plotted against corresponding values of surface area, and the average curve drawn through the plotted points was a straight line. Since the slope of a straight line is constant, and since in the graphs it represented the ratio of "mean surface area" to surface area, it was evident that for each watershed-size group this ratio could be considered constant for 6-ft depths. The same procedure was followed for depths of 8, 10, 12, and 15 ft with similar results. Within the same watershed-size group, the ratio of "mean surface area" to surface area at full depth decreased as the depth increased. However, for the same depths in different groups there were no appreciable differences in the ratios, except that in the 200-to-500 and greater-than-500-acre groups the ratios were approximately 8 per cent less than in the others. These last two groups were made up of only six watersheds, all of which were located in the vicinity of Waco, Texas. The evidence based on so few watersheds, all from one location, was considered inconclusive. It was, therefore, decided to eliminate them and to limit further investigations to the remaining 40 watersheds with a range in size from 6.2 to 177.9 acres.

The next step was to determine the probable error that would result from the use of the average ratios of "mean surface area" to surface area for each depth (2 ft to 16 ft). The average ratio and the standard deviation were determined for each foot of depth. These values were plotted against height of spillway above natural ground h (Fig. 3), and smooth curves drawn through the points. The standard deviation, expressed as per cent error, varied from 9.5 to 13.3 per cent and averaged approximately 12 per cent. In view of the fact that the hydrologic design of farm ponds must be based largely upon estimates of future occurrences[2], this error was considered well within the allowable tolerances.

Where the height of the spillway is fixed, the "mean surface area" of the natural portion of the pond can be computed by the use of Fig. 3. The only required items of information are the height of spillway above natural ground (h in Fig. 1) and the surface area at spillway elevation which can be readily determined with a hand level. In practice, the drainage area is often fixed. Two or more depths and corresponding alternative dimensions of the ex-

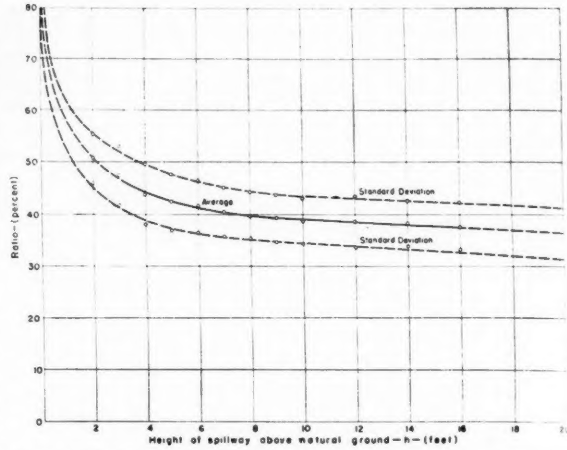


Fig. 3 These curves show the ratio of "mean surface area" to surface area for various heights of spillway above natural ground

cavated portion may, in such cases, have to be tried before arriving at a pond which with a given drainage area will furnish the desired supply. Every such trial of a different depth would involve a separate determination of surface area at spillway level.

In practically all cases the surface area of a pond at some selected depth is required for reasons other than design. No additional field work would therefore be required, if the "mean surface area" for any depth could be expressed in terms of the surface area at that specified depth. A further study was made to see if a relationship existed that would make such a determination possible.

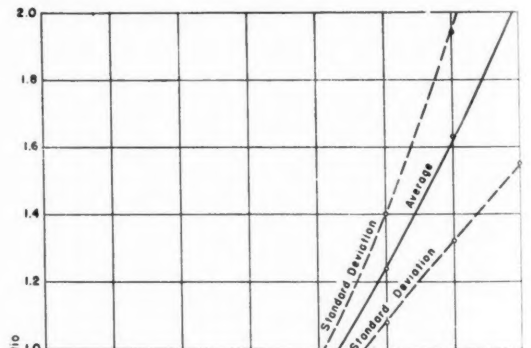


Fig. 4 Curves showing ratio of "mean surface area" to surface area at 6 ft above natural ground for ponds with various heights of spillway

The surface area at 6 ft above the natural ground was selected for comparisons. This area for each watershed was plotted against the corresponding value of "mean surface area" for a pond depth of 4 ft. Similar graphs were prepared to show the relationship between the surface area at 6 ft above ground and the "mean surface area" for pond depths of 6, 8, 10, 12, and 14 ft. In all cases the average curve drawn through the plotted points was a straight line. This indicated that the ratio of "mean surface area" for each of the several depths to the surface area at 6-ft depth could be considered constant. The mean of this ratio for all watersheds for each depth, together with the standard deviation, is shown in Fig. 4 and in the following tabulation:

Spillway height (h_g)	Mean ratio	Standard deviation	Standard deviation, (per cent of mean)
4	0.230	0.059	25.6
6	0.412	0.050	12.2
8	0.632	0.030	4.7
10	0.905	0.065	7.2
12	1.240	0.161	13.0
14	1.631	0.308	18.8
16	2.038	0.489	24.0

An increase in the per cent error with the height of spillway above the 6-ft level had been anticipated as it had been expected that topographical differences between watersheds would increase as the distance from the base of comparison was increased. The large per cent error for the 4-ft spillway height was thought to have been occasioned, not so much by topographical differences between watersheds, as by the small scales of the maps used and by an accumulation of errors in instrumentation and measurement. These include errors in the topographical map and errors in planimetering. It is true that these same errors are present for all spillway heights but, since they are nearly constant for all areas, their proportion of the total increases materially when the areas involved are very small. It may be well to point out that in small farm ponds the height of spillway above natural ground will seldom, if ever, exceed 10 ft.

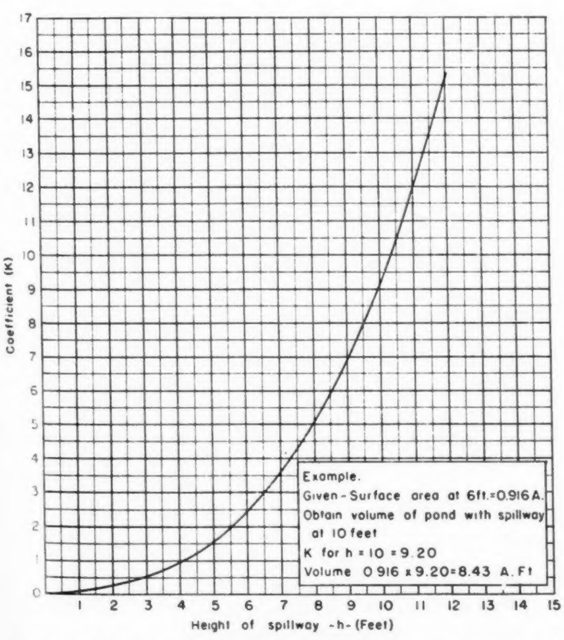


Fig. 5 This graph shows relation of coefficient K to height of spillway above natural ground

The above ratios were multiplied by the corresponding spillway heights to obtain ratios of the volume above the natural ground surface to the surface area at a spillway height of 6 ft. These values were plotted against spillway heights ranging from 0 to 15 ft (Fig. 5) and a smooth curve drawn through the points. With the use of such a curve, it is possible to obtain the volume between spillway level and the natural ground surface for as many spillway elevations as might be necessary in the course of design. The only field work required is a hand level survey to determine the surface area of the pond at 6 ft above the natural ground surface. This area multiplied by the coefficient K of Fig. 5 for any desired height of spillway gives the volume between ground surface and that elevation. Curves similar to that shown in Fig. 5 can be prepared for any other base so that the survey in the field can be made at 4, 5, 7 ft, or any other height above the natural ground. Furthermore, tables can be used instead of curves. Such tables, based on a height of 5 ft above the ground have been used [3,4,5,6,7].

Although the relationships evaluated by the above study gave results that were within acceptable limits of error for the watersheds tested, it is recognized that this would not be true for all types of topography. It is recommended, therefore, that in any area where the use of these graphs is anticipated the area relationships first be tested by computing coefficients for *unexcavated portions* of existing ponds and plotting them on the graph shown on Fig. 5. Four or five tests covering a range of spillway heights of from 4 to 10 ft should suffice to show whether or not it is necessary to modify the Fig. 5 curve.

In conclusion, the authors wish to make clear that the results of this study are intended to take the place of a topographical survey of the reservoir site *only* when the capacity of the proposed pond is very small or when the cost of such a survey would be disproportionate to the construction cost. For a larger development the volume of the reservoir and the "mean surface area" must be determined by standard engineering procedures.

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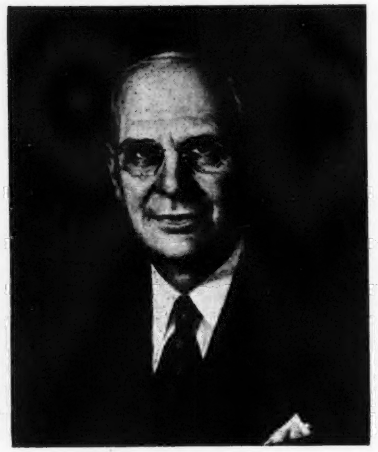
A.S.A.E. Honorary Member Elections



The Council of the American Society of Agricultural Engineers recently elected J. B. Davidson and W. W. McLaughlin to the grade of Honorary Member in the Society, in recognition of their long service and distinguished achievements in the field of agricultural engineering.

J. B. DAVIDSON

W. W. MCLAUGHLIN

IN ITS recent election of Dr. Jay Brownlee Davidson as an Honorary Member, the Council of the American Society of Agricultural Engineers has posted a memorable landmark in its history. It emphasizes the achievement of emeritus status in the Society and the agricultural engineering field, as well as at Iowa State College, by the man who more than all others was its originator, a guiding hand for four decades, and always its modest, willing servant.

Few men in any field have exerted on their profession in its beginning and early years such a strong, sound, progressive personal influence in such a variety of ways over as long a period of time. It is fortunate for agricultural engineers that his chosen field was agricultural engineering. In it, as he readily might have in any other field, he has realized and personified the ideal of a long, full, fruitful, and satisfying professional life, enriched by service to his fellow men.

Easily the one agricultural engineer most widely and favorably known both in and outside the field of agricultural engineering; esteemed as a friend, adviser, leader, and true gentleman of highest character, learning, and achievement, he has been accorded the unofficial but fitting title of "dean of agricultural engineers."

Of a career too full and well known, too studded with achievements and honors to be reviewed in detail, several features may appropriately be mentioned in connection with his election to honorary membership.

As an engineering student at the University of Nebraska, he came under the influence of the late Dean O. V. P. Stout, and thus picked up "the germ of agricultural engineering inspiration" which Dean Stout had absorbed from the late Dr. Elwood Mead. Providence appears to have provided and equipped Dr. Davidson for the special task of cultivating this inspiration to maturity.

Outlining some of the early history of agricultural engineering in 1931, Dean Stout said: "Iowa State College has the distinction of putting into effect the first four-year curriculum, giving the first agricultural engineering degrees, and turning out the greatest number of graduates. Nebraska, in second place in this respect, consoles herself with the reflection that Davidson handled the Iowa job, and that he got his first outlook and inspiration at Nebraska.

"Davidson and Chase graduated in mechanical engineering in 1904. Within three or four years their names were inseparably associated with agricultural engineering. They addressed themselves at once to the task of putting the work on a professional plane and of extending its benefits to all in a position to receive them. They were prime movers in the organization of the American Society of Agricultural Engineers, established advantageous connections on all sides, and in every way made themselves effective in the enterprise of directing and expediting the development of agricultural engineering."

Remaining in the educational field, Dr. Davidson has had the satisfaction of seeing a number of his graduates become able heads of agricultural engineering departments and of seeing their graduates, along with his own, achieve distinction in a wide range of agricultural engineering endeavor.

Feeling the need of contact with other agricultural engineers, then few and far between, Dr. Davidson went to Urbana in 1906 to confer for a few days with F. R. Crane of the University of Illinois and C. A. Ocock of the Uni- *(Continued on page 275)*

ACKNOWLEDGING the recent well-earned retirement of Walter Wesley McLaughlin, as chief of the division of irrigation, USDA, Soil Conservation Service, the Council of the American Society of Agricultural Engineers has recently elected him an Honorary Member of the Society.

In his election to its highest grade of membership the Society is supplementing the honor it bestowed on him in 1940 by award of the John Deere Medal. That award specifically recognized his "distinguished achievement in the application of science and art to the soil." His election as an Honorary Member of A.S.A.E. further recognizes the personal qualities, the work, and the long, faithful service which are related to that achievement.

Mr. McLaughlin retired February 1, 1946, having reached the age of 70 years. Forty of those years were given to service in the U. S. Department of Agriculture, the last twenty as chief of the Division of Irrigation.

Life in the western irrigation country, civil engineering training, and a few years of teaching chemistry led him to an early scientific interest in irrigation and to research in this field, beginning in 1903 as assistant irrigation engineer in the USDA. This developed into a lifetime interest and into professional and technical service, in which his influence progressed from the results of his own research to the inspiration and guidance of growing numbers of younger men, and the administration of major projects. His only years away from the USDA work in irrigation, in 1911-1914, were in the same field as professor of irrigation and drainage at Utah State Agricultural College.

In a field which involved large investments, conflicting interests, and numerous questions of equity, and which attracted numerous promoters lacking in technical background, Mr. McLaughlin held firmly to the highest standards of engineering ethics, continually basing his actions and recommendations on fairness to all and on technical merit, without regard for opportunity for publicity, popular acclaim, or personal gain. This is reflected in the high esteem in which he is held by those who have been privileged to work with and under him; by those in public service and commercial work in the same or related fields; and by those who from a general knowledge of western irrigated agriculture know of him as one of the pioneers of its sound development.

One who worked with and under him for nearly a score of years indicates the range of his contributions in a short paragraph: "McLaughlin built an organization that has conducted authoritative investigations in all phases of irrigation research including duty of water, irrigation methods, economics of irrigation, design of structures and apparatus, water supply forecasting, irrigation law, and numerous other phases of engineering science. His vision, engineering ability, and wide knowledge of the West integrated these studies to the best advantage of all water users. His sensible suggestions and able administration kept the Division's feet always on the ground. Progress always was forward."

His service has been aptly summarized by a fellow worker very briefly as follows: "Mr. McLaughlin has just been retired after 40 years of distinguished service in the development of irrigation in the western states. During that time he has served in high councils on irrigation matters and at *(Continued on page 274)*

Reports of A. S. A. E. Committee Activities

Committee on Research. The activities of the Committee now include those of the former Research Committee of the College Division. Research policy will be discussed at the next meeting of the Committee. The Committee's main objective is to increase the effectiveness of research. This involves industry-wide cooperation on the engineering problems of agriculture. It calls for generalization of results in order to promote analytical, quantitative thinking. It is believed this will hasten mechanization and improved facilities for agricultural processes, help increase the quality and reliability of production, and contribute toward a higher standard of living for everyone. — F. A. Brooks, Chairman

Committee on Extension. The personnel of the Committee consists of agricultural engineers engaged in extension teaching and those with commercial organizations and with land-grant colleges. The Committee has served to encourage extension agricultural engineers to exchange ideas and methods, and it has also sought to encourage higher professional standards and stimulate pride in extension as a career. During the war years the Committee called together extension engineers to plan machinery maintenance programs and other extension activity. The Committee has reviewed the need for more joint preparation of extension materials. — R. C. Hay, Chairman

Committee on Student Branches. In recent months many former student branches of the Society have been reactivated. The Committee sent a letter to all college agricultural engineering departments offering help and suggestions as to how student branches might be reorganized. A letter was also sent to all active student branches asking for suggestions for the student group program at the Society's annual meeting in June. This program has been sponsored by the Committee, and the Committee is arranging for the National Council of A.S.A.E. Student Branches to be reorganized when the students attending the A.S.A.E. annual meeting hold a business session for this purpose. — Walter N. Danner, Chairman

Committee on Safety. The Committee is somewhat unique in that each member has responsibility for a particular phase of the committee work. The primary objectives have been to serve as consultants to and advisers on the engineering reports of safety information and to participate actively in farm safety programs at the local, state, and national level. At least sixteen publications have been prepared under the direct supervision of individual members of the Committee. In addition they have cooperated with other agencies by checking and supplying safety information for publications distributed and programs sponsored by those agencies. Every member of the Committee is active in one or more organizations conducting farm safety programs. Four members are represented on the Farm Committee of the National Safety Council, each holding important subcommittee assignments. The Committee functions through behind-the scenes activities of each member, giving assistance in preparation of safety information and participation in farm safety programs. — V. S. Peterson, Chairman

Committee on Hay Harvesting and Storage (A joint committee of the Power and Machinery, Farm Structures, and Rural Electric Divisions). The primary objectives of the Committee are to secure, exchange, and disseminate information on hay problems and to record changes in general hay handling and storage practices. Its major activity in 1945-46 was the sponsorship of the barn hay-curing conference held at Purdue University, January 7 to 9. The attendance at the conference was in the neighborhood of 200 and it attracted most of the research workers in the field as well as men with interested commercial organizations, together with some farmers. Most of the factual material presented at the conference, much of it being technical information of great value to the future development of barn hay curing — was published in AGRICULTURAL ENGINEERING for March, April, and May. The barn hay curing articles in these three issues are now being reprinted under one cover by the Society. — C. B. Richey, Chairman

Committee on Fertilizer Application (Power and Machinery Division). The primary objectives of the various members of this committee are (1) to organize and conduct research to determine machinery requirements for more effective use of fertilizers, (2) to develop special machinery for conducting field experiments, and (3) to aid research workers, implement manufacturers, farmers and others in selecting, using, or designing improved machines. Numerous experiments and demonstrations of fertilizer placement with respect to the seed or plant have been or are being conducted by individual members. An end-feed, belt-type hopper and various special machines and devices have been developed for conducting field experiments. Manufacturers have improved fertilizer dispensing and placement equipment for a large number of different machines and crop production has been appreciably increased through the use of such equipment. Published reports on activities in which members of the Committee participated from 1930 to date include 12 bulletins, 25 journal articles, 240 mimeographed progress reports, 16 mimeographed committee reports, and various press and radio releases. — G. A. Cumings, Chairman

Committee on Rules for Terrace Building Contests (Soil and Water Division). The Committee was appointed primarily, as its name indicates, to prepare rules and regulations for terracing building contests. The Committee early in the year completed a set of tentative rules for conducting such contests based on the following objectives: (1) To stimulate interest in soil conservation through efficient construction of good-quality terraces, and (2) to demonstrate by competitive processes effective methods of using various types of equipment for terracing. The rules and regulations which the Committee drafted were submitted to the Council of the Society with the suggestion that they be adopted as "tentative recommendations" and made available to sponsors of terracing contests. Suggestions for improvement of the rules have been requested of cooperating sponsors and members of the Society, and the Committee may revise them later if experience indicates that improvements or changes are needed. — T. B. Chambers, Chairman

Committee on Reservoirs and Ponds (Soil and Water Division). The objectives of the Committee for the past year have been to work with other committees of the Soil and Water Division, especially the Committee on Agricultural Hydrology, to obtain information, formulate suggested studies in research, and prepare material for criteria on the planning, design, construction and management of farm ponds and reservoirs with special emphasis on the factors of precipitation, evaporation, silting, seepage, stability of earth fills, constrution methods and equipment, utilization, health and sanitation measures, legal requirements, and economic aspects. Several papers by committee members and others, applying to reservoirs and ponds were published in AGRICULTURAL ENGINEERING during the year as follows: L. B. Krimgold, January, 1945; G. L. Ziemer, September, 1945; V. J. Palmer, December, 1945; M. T. Thompson, January, 1946; A. W. Zingg, January, 1946, and W. D. Potter and D. B. Krimgold, June, 1946. D. B. Krimgold and others are now preparing publication on rates of runoff for various areas, following which publications on the hydrologic designs of farm ponds will be issued. Work on preparation of a bibliography on farm ponds with the USDA Library has been done by D. B. Krimgold and is expected to be issued in the fall of 1946. — Howard F. McColly, Chairman

Committee on Agricultural Hydrology (Soil and Water Division). A statement of the scope, objectives, and proposed activities of this committee was published in AGRICULTURAL ENGINEERING for January, 1946. Three of the six subcommittees mentioned in the statement have now become active. Other activities of the Committee include an attempt to establish contacts with workers on agricultural hydrology in the Soviet Union, and contacts by correspondence have been made with T. S. Forsaith of the Dominion Experimental Station at Swift Current, Sask., relative to proposed hydrologic studies in the four western provinces of Canada. An outline for an agricultural hydrology curriculum for the graduate school of the USDA was prepared by the chairman at the request of the advisory committee of the graduate school. Preliminary informal inquiries have been made regarding the establishment of a department of agricultural hydrology in the "Experiment Station Record." — D. B. Krimgold, Chairman.

Subcommittee on Ground Water, Committee on Agricultural Hydrology. The objectives of the Subcommittee are to explore the possibilities for a more extensive and intelligent use of ground water in agriculture through a series of symposiums covering various phases of the subject; to promote round table discussions of these symposiums at national and section meetings of the Society, and, as a result of these discussions, to make definite recommendations on matters pertaining to the use of ground water in agriculture. To date the Subcommittee has received one paper, entitled "Ground Water in Utah," and has promises of six additional papers. — W. D. Potter, Chairman

Subcommittee on Evaporation from Water Surfaces, Committee on Agricultural Hydrology. Following a conference with the chairman of the Committee on Agricultural Hydrology, a proposed outline of work for this subcommittee has been prepared and submitted for approval. During the past two months the chairman has contacted a number of agricultural engineers with regard to the problems involved in the study of evaporation, the most of which contacts were made at a meeting of the A.S.A.E. Southeast Section at Birmingham. The suggestions received at that time are being incorporated in a proposal.—T. W. Edminster, Chairman

Subcommittee on Water-Plant-Soil Relations, Committee on Agricultural Hydrology. The tentative program of the Committee has been prepared for criticism and amendment by committee members, in order to initiate action and arrive ultimately at a program which will reflect the group's judgment of committee members. As soon as expressions of opinion have been obtained, it will be possible to proceed with the planning of definite symposium. It is expected that the symposium will lead to definite conclusions and recommendations to be submitted to the Society. — C. F. Slater, Chairman

Committee on Fuels and Lubrications (Power and Machinery Oivision). There has been considerable activity by representatives of tractor and engine manufacturers in cooperation with major petroleum companies under the sponsorship of the Cooperative Research Council. This research program has indicated that two tractor fuels having minimum octane of 35 and certain 10 and 95 per cent points to satisfy the design of present tractor engines. At present the Fuel Committee of the American Petroleum Institute is endeavoring to rationalize the program with fuel producers. The A.S.A.E. Committee feels it should support this program as soon as all parties concerned agree. — Elmer McCormick, Chairman

Committee on Electric Light in Farm Production (Rural Electric Division). During the past two years the Committee has compiled a bibliography of 50 or more articles dealing with the subject of electric light in farm production or related subjects. In addition the Committee has prepared a number of charts and graphs which it believes will be suitable for a section on radiation on the farm in an A.S.A.E. data book. The data compiled to date pertains primarily to the ultraviolet end of the spectrum. The data for the visible and infrared will be compiled later. — G. W. Prideau, Chairman

Committee on Agricultural Teacher Training, Committee on Curriculums (College Division). At a meeting of the Committee held in Chicago in December, it was decided that a study be made of the training now provided in farm machanics and/or agricultural engineering, and also to ascertain if possible changes that had been made in training provisions during the past three years. H. B. Swanson of the USDA Office of Education was asked to prepare the study form. This form was reviewed by members of the Committee and the agricultural education advisory members of the Committee. After being reviewed the form was put in final shape, reproduced, and distributed throughout the country in April. It is expected the returns will be in in time so that they may be tabulated, interpreted, and made available for distribution during the summer. — A. J. Schwantes, Chairman

REPORTS OF A.S.A.E. REPRESENTATIVES IN COOPERATIVE RELATIONS WITH OTHER ORGANIZATIONS

Plan Committee, National Adequate Wiring Bureau. The Bureau is an organization set up to promote adequate wiring. The planning committee has nine members, two representing wiring manufacturers, two wiring contractors, and two electrical leagues, two utility companies, and one from A.S.A.E. The activities of the Committee include making a national program for promoting adequate wiring, and the preparation and approval of bulletins, publicity materials, exhibits, and a program for the field representatives of the Bureau who travel over the country in cooperation with other organizations. The Bureau does not write specifications for adequate wiring; it is strictly a publicity and promotional organization. During the year the A.S.A.E. representative presented a specific program for farm wiring promotion with supporting material on why such a program was desirable. It received favorable consideration and is still on the agenda. — Geo. W. Kable

Technical Subcommittee, Industry Committee on Interior Wiring Design. The Industry Committee on Interior Wiring Design is comprised of representatives of ten organizations representing electrical manufacturers, wholesalers, contractors, trade associations, and technical societies. In 1944 it was decided to reconstitute the Committee for the purpose of revising the handbook of interior wiring design and to prepore a handbook of farmstead wiring design. Accordingly, the Committee set up a technical subcommittee to carry on the work on these two handbooks. A.S.A.E. was invited to participate in the project and C. P. Wagner and M. H. Lloyd were appointed to represent the Society on the technical subcommittee. Both Society representatives did active work on the subcommittee, and in addition a large number of A.S.A.E. members cooperated with the subcommittee in reviewing the first draft of the farmstead wiring standards. The handbook of interior wiring design was published in January and the handbook of farmstead wiring design in April. The Industry Committee is continuing its work on wiring handbooks for other types of buildings, but the work of the A.S.A.E. representatives has been completed. — Morris H. Lloyd

Joint Committee on Soil Tilth (American Society of Agronomy and A.S.A.E. cooperating). There has been considerable discussion of soil tilth in recent years, and among other things the Committee has suggested the establishment of a national soil tilth laboratory. Despite all the discussion and recommendations, and the recognized need, very little has been done to improve the situation in regard to ways and means of satisfactorily measuring soil tilth and its effect on plant growth. Perhaps the reason for this is that there is very little enthusiasm among research workers for present methods of approach to the tilth problem, and apparently some new approaches are necessary. Because of this the Committee believes it is highly worth while to make a comprehensive and critical study of the present knowledge regarding soil tilth, and in the light of this study to make recommendations for research needed to be carried out in order to provide the information on soil tilth that is needed. Dr. M. B. Russell of Cornell University, a member of the Committee, has accepted responsibility for preparing this comprehensive report, the subject of which will be "The Physical Condition of Soil in Relation to Plant Growth." Dr. Russell will attempt to prepare his report during the coming year and will embody in it recommendations of members of the Committee and others interested in the subject. This report should be of special value to graduate students and others begining a study of soil physics as it will provide the means for formulating a sound program of tilth research. — I. F. Reed, Chairman of A.S.A.E. Group

National Joint Committee on Fertilizer Application (American Society of Agronomy, American Society for Horticultural Science, Farm Equipment Institute, National Fertilizer Association, and A.S.A.E. cooperating). The objectives of the Committee are (1) to promote and coordinate research, machinery developments, demonstrations and other activities to improve fertilizer application methods and machinery, and (2) to compile current information and formulate general recommendations. From 1929 to 1945, inclusive, approximately 2000 fertilizer placement experiments were reported. During the year 1944 there were 328 experiments with 32 crops in 35 states and 341 demonstrations with 15 crops in 16 states. A large number of machines have been improved and new machines developed in accordance with the research findings. At the last annual meeting of the Committee approximately 300 members and visitors were in attendance. In 1938 the Committee issued recommendations in the form of a 16-page bulletin entitled "Methods of Applying Fertilizer." Current recommendations are being prepared. Progress and special reports are published annually in proceedings in mimeographed form. — G. A. Cumings, Chairman of A.S.A.E. Group

Joint Committee on Grassland Farming (American Society of Animal Production, American Society of Agronomy, American Dairy Science Association, National Fertilizer Association, National Association of Silo Manufacturers, Farm Equipment Institute, Soil Science Society of America and A.S.A.E. cooperating). Organization and planning meetings were held at Albany, Cleveland, Buffalo, and Chicago in 1944. The historical background of the Committee was ably reviewed in December of that year in a report by F. H. Hamlin to the A.S.A.E. Committee on Hay Harvesting and Storage. The Committee resolved itself into three subcommittees — production, preservation, and utilization — for the purpose of summarizing information and data relative to grassland farming with a view to the preparation of a comprehensive report. Material prepared by cooperating groups under the subcommittee leadership was summarized and edited at a meeting held at Ithaca, New York, August 24 and 25, 1945. Committee reports were prepared in mimeographed form and are a matter of record. These form the basis for a digest of all the material which was subsequently prepared for publication in a book, entitled "Green Fields Are Gold." It is expected that copies of the book will soon be available for distribution following delays in printing schedules characteristic of present conditions. — W. C. Krueger, Chairman

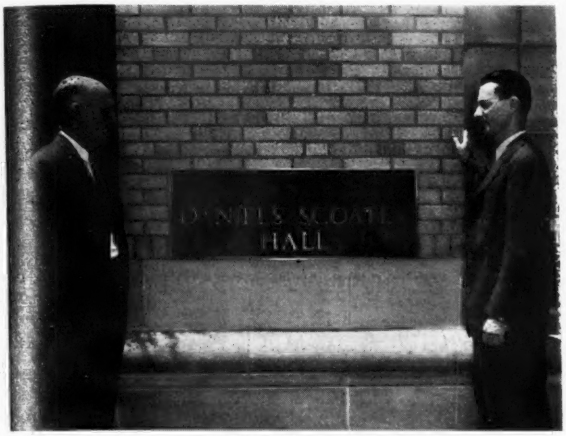
W. W. McLaughlin – Honorary Member

(Continued from page 272)

the same time has directed research of great service to the individual hard-working shovel irrigator."

Another has written: "It is my feeling that he is one of those grand men whose retirement comes as a personal loss to all who have known him."

Mr. McLaughlin became a member of the A.S.A.E. in 1925 and was elected to the grade of Fellow in 1938. He served as member and chairman of various committees, as chairman of the Pacific Coast Section in 1926-27, chairman of the Soil and Water Division in 1931-32, and as vice-president of the Society in 1932-33.



DANIELS SCOATES HALL

In recognition of his distinguished service to the profession and field of agricultural engineering in general, and in particular of his fine work in establishing agricultural engineering at the Agricultural and Mechanical College of Texas, the trustees of the College recently authorized the name "Daniels Scoates Hall" to be given to the agricultural engineering building on that campus, one of the finest of its kind in the country. This is, indeed, a most fitting tribute to the man who was so largely responsible for securing the building, and who at the time was head of the agricultural engineering department—the late Daniels Scoates, a past-president of A.S.A.E. In this picture are Fred R. Jones (left), present head of the agricultural engineering department, and William D. Scoates, son of Daniels Scoates

J. B. Davidson—Honorary Member

(Continued from page 272)

versity of Wisconsin. The three saw that similar and larger meetings would help advance their work, and constituting themselves as a committee planned the meeting at Madison, Wis., in December, 1907, at which they and a few others organized the American Society of Agricultural Engineers.

Dr. Davidson, then 27 and professor of agricultural engineering at Iowa State College, was elected first president of the new organization.

His firm early grasp on the importance and direction of sound progress in agricultural engineering and the American Society of Agricultural Engineers shows up in his annual address to the group in December, 1908, at the close of his term as president. It outlined principles and policies still sound, and predicted with remarkable accuracy the nature and direction of agricultural engineering progress through four decades of greater technical advancement than the world had previously seen. Picture these thoughts against a background of kerosene lamps, four-horse teams, steam-powered threshing rigs, mud roads, and 10-mile-per-hour speed limits: "The Society has an important field in designating and emphasizing the importance and value of the work of the agricultural engineer. By presenting a solid front to the world, we shall not only advance ourselves, but I sincerely believe that we shall be able to render the world and humanity a commendable service worthy of the world's best. Agricultural engineering instruction in the colleges is only in its infancy, and the Society should be a factor in establishing definitely the science, theory, and practice of agricultural engineering.

"The work, then, of this body must be largely educational, for not only must the science of agricultural engineering be developed but its practice must be given to the world. As soon as better homes, better and more improved machinery, more complete and refined drainage and irrigation systems, and better highways are demanded by the people in general, in like proportion the prosperity of the nation and the agricultural engineer will advance."

Later, and before the Society he helped to found could afford a paid secretary, he was one of several who for a time helped hold it together and make it grow by taking on the secretary's work as a "labor of love." He was secretary-treasurer of the Society in 1920 when it initiated publication of AGRICULTURAL ENGINEERING in September of that year.

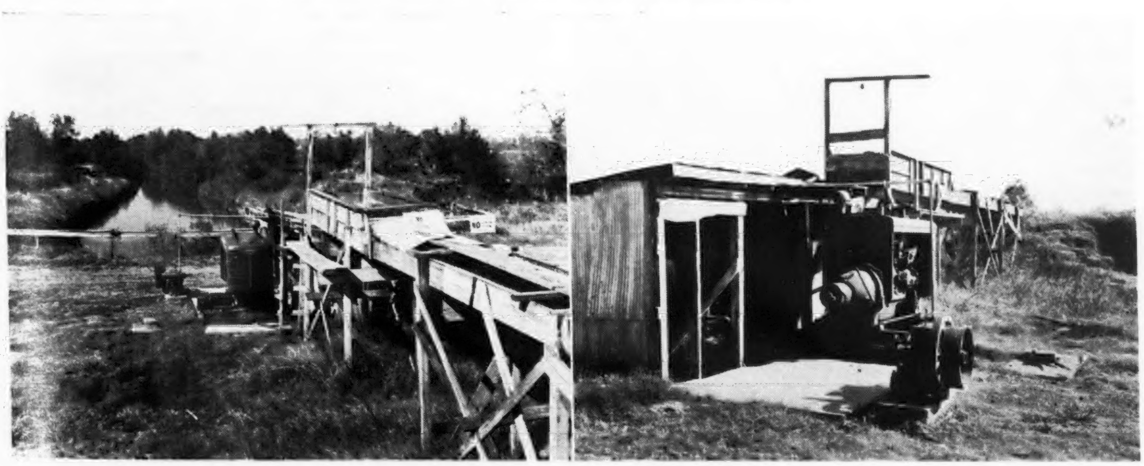
Throughout his career Dr. Davidson has repeatedly served on the Society's Council, on numerous of its committees, and as its representative to other groups. With the exception of times when he has been abroad, he had been continuously available and frequently called upon as an unofficial adviser on various phases of the Society's activities.

Paralleling his work as an educator and administrator, Dr. Davidson has been a leader in developing the technology of agricultural engineering. In 1910 he was making dynamometer tests on farm equipment. He was probably more responsible than any other one person for the progressive mechanization of corn production. He was a pioneer in developing the engineering economics of farm equipment use.

In 1933 the American Society of Agricultural Engineers paid tribute to his technical, professional, and educational accomplishments by awarding him the Cyrus Hall McCormick Medal "For Exceptional and Meritorious Engineering Achievement in Agriculture."

In retiring as active head of the agricultural engineering department at Iowa State College on July 1st, Dr. Davidson is being relieved of a heavy administrative load in order that the world may have fuller use of his valued professional counsel, enriched and matured as it has been by nearly one-half century of leadership experience in the agricultural engineering field. His many friends look forward to long continued and even greater service in his new capacity.

As though in return for his magnificent contribution, time and the world have dealt kindly with Dr. Davidson. He is one of the few privileged to live to see his influence and inspiration achieve the quality of immortality.



PUMPING WATER FOR RICE IRRIGATION

These pictures were taken in the Stuttgart, Arkansas, rice-growing area where water is a very important item. A 100-hp International UD-18 diesel power unit is shown pumping water for re-use from a large drainage ditch which is part of a district drainage system. The power unit is connected to a pump which is raising water 20 ft through a 16-in pipe to a flume leading to a main distributing canal at the rate of 7500 gpm. The outfit is owned by two large rice growers near Stuttgart

NEWS SECTION

Georgia Section Meets

THE Georgia Stction of the American Society of Agricultural Engineers held an interesting meeting at Barrow Hall, the agricultural engineering building on the University of Georgia campus at Athens, on May 25. The central theme of the program was "Agricultural Engineering in Georgia." With Section Chairman H. D. White presiding, the program opened with an account of the program of the agricultural engineering department by Department Head R. H. Driftmier. This was followed by a talk on the agricultural engineering extension program for the state by Extension Engineer G. I. Johnson.

The third item on the program was a symposium on the cooperative setups between the University of Georgia ag engineering department and other organizations, as follows: Divisions of Agricultural Engineering (BPISAE), USDA — J. W. Simons; USDA extension — J. C. Oglesbee; SCS research, W. J. Liddell; SCS operations, C. W. Chapman; state agricultural experiment stations, J. L. Shepherd; Rural Electrification Administration, H. S. Glenn; industry, H. R. Roberts. This symposium was followed by a review of activities of graduates by W. N. Danner, Jr., of the department staff.

At the business session of the Section, the following officers were elected for 1947: Chairman, H. S. Glenn, rural electrification specialist, Georgia Agricultural Extension Service; vice-chairman, W. R. Seaton, Statesboro, Ga., and secretary-treasurer, W. J. Liddell, research assistant professor of agricultural engineering, University of Georgia.

New Freshman Scholarship Awards in Georgia

THE agricultural engineering department of the University of Georgia has announced two new freshman class scholarship awards for beginning study in agricultural engineering.

Any Georgia farm boy graduating from high school in 1946 will be eligible to compete. Winners will be selected by a committee on the basis of high school scholarship and a short paper on the subject "The Place of Power Machinery in Georgia's Agriculture."

The first award is $200; the second award is $125. These awards were made available through the courtesy of the Atlanta Farm Equipment Club.

New Hampshire to Have A-E Department

AFTER several years as a one-man division in the agronomy department, the trustees of the University of New Hampshire recently authorized the setting up of a full-fledged department of agricultural engineering at that institution. George M. Foulkrod, who is now extension agricultural engineer for the state, will head the new department.

Directory Corrections

ERRORS in listings in the 1946 A.S.A.E. Membership Directory will be corrected when discovered and reported by Society members, and the correct listings will be given in this column. Changes in business connection, address, etc., subsequent to closing date for printing will not be included.

Hipple, J. L. (M)—Engineering supervisor, farm implement division, International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill. (1945) PM

Hitchcock, R. B. (M)—Inspector general of engineering, International Harvester Export Co., 1 Place Stephanie, Brussels, Belgium. (1920) PM

Louden, R. W. (M)—Farm line manager, The Louden Machinery Co., Fairfield, Iowa. (1939) FS

McCormick, Elmer (M)—Chief engineer, John Deere Tractor Co., Waterloo, Iowa. (1920) PM

McCormick, Fowler (M)—President, International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill. (1934) PM

Tucker, H. H. (A)—Director, Coke Oven Ammonia Research Bureau, 50 West Broad, Columbus 15, Ohio. (1939) G

Trullinger, R. W. (F)—Assistant chief, Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C. (1914) G

Personals of A.S.A.E. Members

John M. Anderson, who served as a captain in the field artillery in France and Germany during the war, has received his discharge and has resumed his duties as farm structures field engineer for the Structural Clay Products Institute. He is located at the Institute's regional office at Ames, Iowa.

Thomas L. Baggette, who served as a major in the 114th Field Artillery of the Army during the war, and more recently as agricultural engineer at the Delta Branch Station of the Mississippi Agricultural Experiment Station, is now research and sales engineer for the New Holland Machine Company, and is doing special work in connection with the company's "Sizz-Weeder."

Clarence J. Bush is now an associate engineer with the Rural Electrification Administration, USDA, and is located at the Washington REA headquarters. During the war he served as a captain in the 380th Bomb Group of the Army Air Force.

Elwin D. Butler is now a district engineer with the U. S. Soil Conservation Service and is located at San Augustine, Tex.

J. E. Christensen has resigned as irrigation and drainage engineer of the Regional Salinity Laboratory of the U. S. Department of Agriculture located at Riverside, California, to accept the position of dean of the school of engineering, trades and industries at the Utah State Agricultural College, Logan. He will assume his new duties July 1.

Fred M. Crawford is employed as agricultural engineer with the Illinois Northern Utilities Co., at Dixon, Ill.

Roy D. Crist has recently been made a work-unit conservationist with the U. S. Soil Conservation Service at Belleville, Kansas, where he will be engaged in furnishing technical assistance to the soil conservation district of Republic County. During the war he was on duty with the Eighth Air Force as a gunnery observer.

Richard A. Duncan was recently discharged from active duty with the Army, having served as a major in the Corps of Engineers. He has returned to his former position as field engineer with the Hawaiian Sugar Planters Association at Hilo, Hawaii.

S. M. Elliott, who until recently was manager of testing in the tire division of the B. F. Goodrich Company, has recently joined the Seiberling Rubber Company at Akron, Ohio, where he is now assistant manager of the company's agricultural tire sales department.

Bertis L. Embry, who served as an ensign in the U. S. Naval Reserves during the war and who has returned to civilian status, has entered the employ of the USDA Rural Electrification Administration, with the rating of agricultural engineer.

Irby S. Exley is associated with the Doolittle Tractor and Implement Co., Jacksonville, Fla., as zone manager for distribution of Ford-Ferguson farm machinery.

Charles C. Fisk who served as a lieutenant in the Army Air Force during the war, is now engaged as a hydrologic engineer on spillway design flood studies with the hydrology division of the Bureau of Reclamation, U. S. Department of the Interior, and is located at Denver, Colorado.

Harold L. Geiger, metallurgical engineer and head of the Chicago section of the development and research division of the International Nickel Company, was recently elected chairman of the Chicago chapter of the American Society for Metals. During the past year he served as vice-chairman of the chapter.

H. S. Glenn was recently named manager of the Colquitt County (Ga.) Rural Electric Cooperative, with headquarters at Moultrie.

Thomas E. Griffin, is now employed as assistant agricultural engineer (farm planner) with the U. S. Soil Conservation Service at Albuquerque, New Mexico. He was recently released from the army where he served as a lieutenant in the Signal Corps during the war.

H. T. Hargrave is cattle ranch foreman for the Hargrave Ranching Co., Ltd., at Walsh, Alberta, Canada.

Harris H. Hart is now a tractor tire designer for Goodyear Tire & Rubber Co. at Akron, Ohio, and is engaged on the design of tires for farm tractors. During the war he served as a lieutenant in the U. S. Navy.

(Continued on page 278)

Personals of A.S.A.E. Members

(Continued from page 276)

John R. Haswell, professor of agricultural engineering extension, Pennsylvania State College, was recently cited in "Capper's Farmer" for having "put on dynamite-ditching demonstrations for 25 years with the result that Pennsylvania is one of the leading states in the use of agricultural dynamite for dirt moving jobs."

Elwyn S. Holmes has resigned as research assistant in agricultural engineering, A. & M. College of Texas, to accept appointment as extension agricultural engineer in the agricultural engineering department at the University of Kentucky, Lexington.

James C. Hundley, who served as a lieutenant in the U. S. Naval Reserves during the war, is now associate extension agricultural engineer, specializing in rural electrification, at the University of Tennessee, Knoxville.

Lloyd W. Hurlbut is a new member of the agricultural engineering staff at Purdue University. He has the rank of assistant professor and will engage in teaching and research work in the power and machinery field.

O. W. Israelsen, research professor of irrigation and drainage, Utah Agricultural Experiment Station, is one of the authors of Bulletin No. 322 issued by that station, and entitled "Irrigation Companies in Utah—Their Activities and Needs."

Henry Karrer, who recently resigned as engineer for the Patterson Water Co., is now field office superintendent of the U. S. Bureau of Reclamation at Bakersfield, Calif., and is engaged in engineering work on irrigation and hydrology.

S. H. Keller, who has been serving as assistant agricultural engineer of the U. S. Soil Conservation Service at Chickasha, Okla., was recently assigned the job of opening the Cowley County soil conservation district in south central Kansas, in which position he will serve as conservationist in charge of the district.

L. L. Kelly, recently released from military service, is now a soil conservationist in the water conservation division of the U. S. Soil Conservation Service, and is engaged in engineering work in connection with the USDA flood control program.

George Krieger, in charge of the agricultural division, Ethyl Corporation, was recently named chairman of the newly formed agricultural development committee of the American Petroleum Institute.

Donald E. Kuska has accepted employment with the Aerco Corp., Hollydale, Calif. He was formerly with the Curtis Wright Corp. at Columbus, Ohio.

Andrew J. Longley, after spending five and one-half years in the Army, first with the cavalry and later with the combat engineers, attaining the rank of lieutenant colonel, has now been honorably discharged and has resumed his work with the U. S. Soil Conservation Service as district conservationist in the Southwest District of Kansas.

George C. Marti is now in the employ of the International Harvester Company of Mexico, S.A., at Saltillo, Coah, Mexico. He is assistant to the superintendent in charge of plant construction, supervision, and all engineering matters concerned with both construction and future operation of the plant.

W. N. McAdams is rejoining the agricultural engineering staff at Clemson Agricultural College, following a military leave of absence for three years, during which time he served as an aviation ordnance officer in the U. S. Naval Reserve.

J. R. McCalmont was recently released from the Navy and has returned to work in the Divisions of Agricultural Engineering, BPISAE, USDA, at Beltsville, Md., where he will be in charge of livestock shelter investigations.

Bruce F. McDonald, who served as a lieutenant in the U. S. Naval Reserves during the war, has recently taken a position as plant engineer with Joseph E. Seagram & Sons at Louisville, Kentucky. His work will include designing and estimating labor and material costs.

Eugene W. McGaan is assistant agricultural engineer, U. S. Soil Conservation Service. He is working in the southeastern counties of Iowa as drainage and engineering specialist, with headquarters at Burlington.

Howard O. McMillan, Jr., has been discharged from the Army where he served in the 20th Armored Division, and is working for C. F. Haglin and Son, Inc., of Minneapolis, Minn., in the general construction business.

Raymond T. McVeety was recently discharged as technical sergeant, 3234th Engineer Technical Intelligence Team, of the Army and is now employed as engineer in the design, development and testing of farm implements at the LaCrosse, Wisconsin, plant of the Allis-Chalmers Manufacturing Co.

Fred Meyer, Jr., who served with the Corps of Engineers of the Army during the war, is now engaged as work unit conservationist with the U. S. Soil Conservation Service at Syracuse, Kansas. His work is that of technician in charge of the Hamilton County soil conservation district. *(Continued on page 280)*

Personals of A.S.A.E. Members

(Continued from page 278)

Edwin T. Mims is now assistant director of traffic, with rank of captain, for the Fourth Ferrying Group, Continental Division, Air Transport Command, with headquarters at the municipal airport at Memphis, Tenn.

Aldert Molenaar recently resigned his position as project engineer on the Rathdrum Prairie Irrigation Project, USDA Farm Security Administration, at Cour d'Alene, Idaho, to become extension agricultural engineer at the State College of Washington. At present he is devoting most of his time to farm structures extension, but will eventually work in the field of irrigation.

George O. Mullan is rural representative for the Potomac Edison Co., and is located at Hagerstown, Md.

Marvin Nabben has taken a position as agricultural engineer in the rural sales department of the North States Power Co., and will be engaged in work dealing with the application of electricity to farm uses.

Charles W. Naylor, who served as a lieutenant in signal work with the Army during the war, is now engaged as agricultural engineer with the U. S. Soil Conservation at Junction City, Kans.

Harold L. Newel, a captain in the 80th Field Artillery of the Army during the war, has received his discharge and accepted a position as junior engineer with the Texas Oil Refinery at Wilmington, Calif.

Joseph C. Newell, who served as a lieutenant in the 355th Infantry during the war, is now assistant county agricultural agent for Scott County, Arkansas, with headquarters at Waldron.

Ralph E. Patterson, a graduate in agricultural engineering of Ohio State University in 1942, has joined the faculty of Pennsylvania State College as instructor in agricultural engineering.

A. H. Powell is now engaged as superintendent of the Wellsville (Utah) plant of the Carnation Co. and is in charge of operations involved in the production of evaporated milk at that plant.

Harold D. Prichard is soil conservationist in farm planning work for the Soil Conservation Service at Westminster, S. C.

Francis M. Roberts, who served as an engineer in the U. S. Army Air Forces during the war, is a civilian again and holds a position as agricultural engineer with the U. S. Soil Conservation Service at Afton, Wyoming.

Milo J. Salter was recently released from army service and is now engaged in farm tractor development work in the tractor engineering department of the Allis-Chalmers Mfg. Co., at West Allis, Wis.

E. C. Schneider has resigned as assistant instructor in agricultural engineering at Cornell University, to accept appointment as assistant professor of agricultural engineering at the University of Vermont, Burlington.

John A. Scholten, research engineer, USDA Forest Products Laboratory, is now in Japan filling an assignment as technical consultant to the head of the forestry division, section of national resources, Supreme Allied Command for Japan and Korea. His responsibilities include making a general survey of forest researches and facilities to guide Army policy on production and procurement of wood supplies during the military occupation of that area.

William M. Shepherd, until recently director of rural development, Arkansas Power and Light Company, was recently promoted to larger responsibilities and is now director of the company's industrial and rural development division.

A. J. Sprecher has returned from Army duty to take up work as district engineer of the Kiowa (Colo.) Soil Conservation District.

A. J. Sprecher is an agricultural engineer in the U. S. Soil Conservation Service and district engineer on the Kiowa (Colo.) soil conservation district.

James P. Stafford, Jr., is now engaged as a junior agricultural engineer with the U. S. Soil Conservation Service at Wewrika, Oklahoma. During the war he served as a captain in the Corps of Engineers of the U. S. Army.

Herbert N. Stapleton, who has been in the Army about four years and who saw service in both the European and Southwest Pacific areas, attaining the rank of major, has recently returned to civilian status and resumed his former position as agricultural engineer with the Green Mountain Power Company at Burlington, Vermont.

James L. Strahan has resigned as agricultural engineer for the Flintkote Company, to become technical director of the Asphalt Roofing Industry Bureau with headquarters at 2 West 45th Street, New York, N. Y.

Norris P. Swanson, who served four and one-half years in the armed services as an ensign with the U. S. Naval Reserves, is a civilian again and has returned to the U. S. Soil Conservation Service at Balmorhea, Texas, where he is employed as a P-2 agricultural engineer.

L. F. Thompson is soil conservationist, U. S. Soil Conservation Service at Warrenton, N. C. *(Continued on page 282)*

Personals of A.S.A.E. Members

(Continued from page 280)

O. J. Trenary, who for the past few years has been connected with the farm industry division of the General Electric Co., has resigned to accept appointment as extension agricultural engineer at Colorado State College, where he will be in charge of extension work in farm buildings and farm machinery.

C. H. Van Vlack, extension associate professor of agricultural engineering, Iowa State College, is author of Bulletin P 78 recently issued by that institution, entitled "Modernizing a Midwestern Farmhouse".

Richard L. Walker is a lieutenant colonel in the Army Air Force, and is engaged as base commander of the Army Air Base at Pope Field, Fort Bragg, North Carolina.

Eugene R. Whitacre is now employed as a research engineer in product testing and experimental work at the tractor works of the International Harvester Company at Chicago.

Lowell L. Whitaker is conservation engineer with the soil and moisture conservation office of the Osage Indian Agency at Pawhuska, Okla.

Carl Widseth recently resigned as a regional service manager for Harry Ferguson, Inc., to become associated with Miller-Pöhl, Inc., Davenport, Iowa. He will manage the company's steel building and farm equipment division.

Homer D. Witzel, formerly agricultural engineer at the Battle Creek, Michigan, works of The Oliver Corp., is now project engineer of the Harris Manufacturing Co., at Stockton, Calif.

Alvah E. Worth is engineering specialist for Vermont and New Hampshire on soil and water conservation and drainage problems for the U. S. Soil Conservation Service. He is located at Poultney, Vermont.

F. D. Yung, research engineer in rural electrification, Nebraska Agricultural Experiment Station, is author of three "Agricultural Engineering Progress Reports" recently issued by that station, namely, No. 12A on a zero storage cabinet, No. 13 on a water-cooled egg storage cabinet, and No. 14, a preliminary report on ear corn drying.

G. L. Ziemer, assistant director, Iowa State Conservation Commission, was recently honored by the Iowa Engineering Society, which awarded him the John Dunlap Award for 1945, which the Society gives annually to the author of the best published paper presented before that organization. The paper on which the award was based is the one entitled "Conservation Factors in Flood Control Planning," appearing on pages 372-378 of AGRICULTURAL ENGINEERING for September, 1945.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Paul C. Baker, managing editor, Farm Implement News, 431 S. Dearborn St., Chicago 5, Ill.

Reginald J. Berry, assistant to registrar, Clemson Agricultural College. (Mail) 807 Elizabeth Street, Anderson, S.C.

Thomas Teh-Chung Chang, graduate student, agricultural engineering div., University of Minnesota, St. Paul, Minn.

Sheng-Tsu Chen, graduate student, agricultural engineering div., University of Minnesota, St. Paul, Minn.

Glenn G. Commons, agricultural engineer, Soil Conservation Service, USDA. (Mail) P. O. Box 910, Nacogdoches, Tex.

Charles R. Cook, regional educational manager, Harry Ferguson, Inc. (Mail) 319 Latham Square Bldg., Oakland 12, Calif.

H. Y. Cott, work unit conservationist, Soil Conservation Service, USDA. (Mail) Box 63, Scott City, Kansas.

J. P. R. Cristel, rural electrification extension worker, Shawinigan Water & Power Co., Montreal 29, Quebec, Canada. (Mail) Apt. 27, 4970 Queen Mary Road.

Roy C. Dawson, bacteriologist, Soil Conservation Service, USDA. (Mail) University of Nebraska, Lincoln 1, Neb.

H. W. Derry, manager, new industries dept., Pacific Power & Light Company. (Mail) Public Service Bldg., Portland 4, Ore.

Boyce L. Dyer, work unit conservationist, Soil Conservation Service, USDA. (Mail) Y.M.C.A., Athens, Ga.

Henry C. Gotcher, president and designing engineer, Gotcher Engineering & Mfg. Co., Inc., 316 6th St., Clarksdale, Miss.

Peichung Hsu, graduate student, agricultural engineering div., University of Minnesota, St. Paul 8, Minn. (Mail) 1412 Grantham St.

Palmer Jones, head, agricultural div., Owens-Corning Fiberglas Corp., Newark, Ohio. *(Continued on page 284)*

Applicants for Membership

(Continued from page 282)

Liang Ruenn Kao, graduate student, agricultural engineering division, University of Minnesota, St. Paul, Minn.

K. Martin Keyes, graduate student, Michigan State College. (Mail) 1024 Birch St., Lansing 15, Mich.

Leonard Martin Klein, associate agricultural engineer, Bureau of Plant Industry, Soils & Agricultural Engineering, USDA. (Mail) 3750 Oak Creek Road, Corvallis, Ore.

Ketso Li, graduate student, agricultural engineering division, University of Minnesota, St. Paul 8, Minn.

Lloyd W. Lundin, land classification, Bureau of Reclamation, USDI. (Mail) Box 2130, Bismarck, N.D.

Everett D. Markwardt, farmer, Bisbee, N.D.

Ross R. Mauney, agricultural engineer, Arkansas Power & Light Co. (Mail) Pine Bluff, Ark.

A. G. Mayer, manager, farm development, The Washington Water Power Co., West 825 Trent Ave., Spokane, Wash.

Mark McNiel, utilization specialist, Shenandoah Valley Electric Corp. (Mail) 92 Shenandoah Ave., Harrisenburg, Va.

Carl H. Neitzke, extension specialist, agricultural engineering dept., University of Wisconsin, Madison, Wis.

Elwood F. Olver, instructor, agricultural engineering dept., Pennsylvania State College, State College, Pa. (Mail) 608 W. Fairmount Ave.

G. Vishwanath Rao, International Harvester Experimental Farm, Hinsdale, Illinois.

George M. Scherrer, engineer, Rural Electrification Administration, USDA, Washington, D. C. (Mail) 3148 Wisconsin Ave., N.W.

Quinten E. Shiley, service manager, Unit Tractor & Equipment Co., Fargo, N. D. (Mail) 1026 Broadway.

Jack S. Slusser, division rural supervisor, Pennsylvania Power & Light Co. (Mail) Wilkes-Barre, Pa.

A. E. Smith, chief designer, Dening & Co., Ltd., Chardstock, Devon, England. (Mail) Kitbridge Cottage.

Elmer H. Smith, rural supervisor, Kansas City Power & Light Co., 1330 Baltimore Ave., Kansas City, Mo.

H. D. Smith, general sales manager, R. M. Wade & Co. (Mail) RR No. 10, Box 1289, Portland 2, Ore.

G. W. Steinbruegge, instructor, agricultural engineering dept., University of Missouri, Columbia, Mo.

Walter Sway, graduate student, agricultural engineering div., University Farm, St. Paul 8, Minn.

Peter Ding-lai Tao, graduate student, agricultural engineering div., University of Minnesota. (Mail) P. O. Box 1803, University Farm, St. Paul 8, Minn.

Joe Tseng, graduate student, agricultural engineering div., University of Minnesota. (Mail) P. O. Box 1809, University Farm, St. Paul 8, Minn.

Albert W. Wang, graduate student, agricultural engineering div., University of Minnesota, St. Paul 8, Minn.

F. D. Wilborn, assistant editor Farm Implement News, 431 South Dearborn St., Chicago 5, Ill.

Philip H. Wilson, district agricultural engineer, agricultural engineering dept., Cornell University, Ithaca, N.Y.

Lawrence K. C. Wu, graduate student, agricultural engineering div., University of Minnesota, St. Paul, Minn. (Mail) 2081 Buford Ave.

George E. Zerfoss, associate agricultural engineer, Tennessee Valley Authority, 607 Arnstein Bldg., Knoxville, Tenn.

TRANSFER OF GRADE

Richard G. Boardman, farm manager and custom machinery operator, Chardon, Ohio. (From Junior Member to Member)

Fred M. Crawford, Major, U. S. Army Coast Artillery. (Mail) Peabody, Kansas. (From Junior Member to Member)

James G. Lassetter, soil conservationist, Soil Conservation Service, USDA. (Mail) P. O. Box 37, Chipley, Fla. (From Junior Member to Member)

Wharton A. LeBlanc, agricultural engineer, General Gas Corp., Baton Rouge, La. (From Junior Member to Member)

Joseph K. Park, agricultural engineer, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA. (Mail) Agricultural Engineering Dept., Clemson Agricultural College, Clemson, S. C. (From Junior Member to Member)

John W. Weaver, Jr., research associate professor of agricultural engineering, North Carolina Agricultural Experiment Station, Raleigh, N. C. (From Junior Member to Member)

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN: FEBRUARY—O-448, 452, 474, 479. APRIL—O-492. MAY—O-494, 495, 496, 497, 498, 499, 500, 501, 502, 503.

POSITIONS WANTED: FEBRUARY—W-200, 207, 209, 210, 211, 227, 233, 234, 235, 248, 254, 267, 270, 271, 274, 282, 289, 292, 295, 296. APRIL—W-232, 237, 240, 247, 253, 255, 256, 258, 262, 265, 266, 273, 276, 277, 281, 283, 285, 287, 290, 291, 297. MAY—W-300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313.

Attention is invited to the desirability of checking on the housing situation when considering a new location.

POSITIONS OPEN

AGRICULTURAL ENGINEER for work on pineapple plantations in Hawaii. Job requires wide range of engineering experience in farm machinery and utilities, including stationary diesel power plants, for plantations which are largely self-contained units. Prefer man with BSAE degree or equivalent. Salary open. O-504

SHOP FOREMAN for supervision of production including arc welding in jigs, lathe work, spray painting, sheet metal work and assembly of commercial spreaders of various sizes and types for small manufacturer in middle west. Man need not be college graduate but must have definite technical training in metals and preferably a good working knowledge of shop procedure and management. Must be Protestant, a total abstainer from liquor, clean in morals and habits, with liking and aptitude for shop work, and ability to lead and encourage other workers. Ample opportunity for advancement for man who meets requirements. Age 24-40. Salary open. O-505

DESIGN ENGINEER to take charge of design, development,, and field testing of manure spreaders, corn pickers, farm wagons, lime sowers, and other farm machinery for new division of established company. Eastern location. Prefer man with BSME degree or equivalent, and wide background in the design and development of farm machinery, including at least 5 years experience with a leading company. Should be capable of leading other men. Age 30-50. Salary open. O-506

EXTENSION AGRICULTURAL ENGINEER for full-time farm structures extension work in midwestern state. Thorough training in farm structures, either in agricultural engineering or architectural course is required. Experience in farm structures or other light construction desirable. Age, about 30. Salary open, depending on qualifications. O-507

AGRICULTURAL ENGINEER wanted by the Allahabad Agricultural Institute, Allahabad, India, for teaching position. Minimum qualifications, degree in agricultural engineering and some farm experience. Postgraduate degree desirable. Duties would be primarily teaching, with some opportunity to participate in research and extension. Candidate must be active Christian interested in mission work. Discharged veteran with slight handicap eligible if in good health otherwise. Applicants may correspond with Allahabad Agricultural Institute, 156 Fifth Ave., New York 10, N. Y.

POSITIONS WANTED

AGRICULTURAL ENGINEER desires development, research, or extension work in soil and water or farm machinery field, in public service or private industry. BSA degree in 1942, and BSAE degree in 1946, North Dakota State College. Army experience chiefly as supply sergeant in military police unit. No physical defects. Available after June 17. Married. Age 31. Salary open. W-314

AGRICULTURAL ENGINEER desires research, sales, or service work in any branch of agricultural engineering, with private company serving agriculture. BSAE degree, University of Maine, 1941. Army experience as inspector of engineering materials, link-trainer instructor, photo-intelligence officer, and weather officer. Available immediately. Age 26. Salary $3500. W-315

AGRICULTURAL ENGINEER desires teaching, research, or extension work in soil conservation or farm machinery, in public service or private industry. BSAE degree, Kansas State College, 1944. Experience as inspection and production engineer, 3 mo; inspector of engineering materials for Navy, 16 mo. Now in Army; eligible for discharge on evidence of employment. Married. Age 23. Salary open. W-316

AGRICULTURAL ENGINEER desires development or extension work in power and machinery, preferably in south central states. BSAE degree, North Dakota State College, 1942. Experience during school years in county agent's office and extension division. Army experience as single-engine fighter pilot. No physical defects. Available July 15. Single. Age 27. Salary $2400. W-317

AGRICULTURAL ENGINEER desires development or sales work in farm machinery or farm structures field. BSAE degree expected in July, Kansas State College. Long experience in field use of power machinery, plus 6 mo practical experience in design of farm structures. Army commissioned experience as infantry combat platoon leader. No physical defects. Available after July 23. Married. Age 24. Salary $2700. W-318

(Continued on page 288)

PROFESSIONAL DIRECTORY

PERSONNEL SERVICE BULLETIN

(Continued from page 286)

AGRICULTURAL ENGINEER desires work in research or service on farm machinery or rural electrification with private company. BSAE degree, with additional study in strength of materials and industrial drawing. Experience in farm shop, surveying, mapping, and for Navy as senior inspector of engineering materials. No physical defects. Available immediately. Single. Age 27. Salary open. W-319

AGRICULTURAL ENGINEER desires work as research or project engineer in a government agency. BSAE degree, Kansas State College, 1944. Commissioned service in Navy. No physical defects. Available in September. Single. Age 24. Salary $2800. W-320.

AGRICULTURAL ENGINEER desires extension, research or project engineering work in soil and water field with public service agency. BSAE degree, University of Minnesota, March 1946. Commissioned service in Army. No physical defects. Available August 1. Married. Age 26. Salary $2500. W-321

AGRICULTURAL ENGINEER desires sales, research, development, or design work in farm machinery for private company or public service agency. BS degree in agriculture and in mechanical engineering, University of Wisconsin, 1942. Experience in farm operations, time study on general machine shop operations; general engineering drafting, detailing, and layout work; testing, development, and service of farm machines. Available immediately. Single. Age 26. Salary open. W-322

New Literature

"A PROGRESS REPORT ON THE INVESTIGATION OF THE VARIOUS USES OF ELECTRICITY ON THE FARMS OF WASHINGTON FOR THE YEAR 1945," by John B. Dobie, investigator, and L. J. Smith, secretary and part-time investigator, Washington C.R.E.A. Mimeographed, 8½x11 inches, 71 pages. Limited distribution.

This 21st annual report of the Committee informally describes procedures and results of projects on (1) fundamental requirements of poultry breeding, (2) hay drying, (3) pea vine drying, (4) preliminary electric house heating studies, (5) home air-conditioning tests at Ephrata, (6) poultry house cooling, (7) ultraviolet lighting of turkey breeding flocks, (8) livestock water heating, (9) fly control in milkhouses, and (10) the electrically heated greenhouse.

"FARM EQUIPMENT SERVICE," by Fred R. Jones, head, department of agricultural engineering, Texas A & M College. Paper, 5½x8½ inches, 147 pages. W. R. C. Smith Publishing Co., Atlanta, Ga. Price not quoted.

This is a reprinting of a series of articles published in recent years in "Southern Hardware", and is designed to put the material in more permanent and convenient reference form for use by farm equipment dealers and service men. Subjects covered include the fundamentals of service operations, tractor engines—their construction, reconditioning and servicing, servicing the tractor fuel system, servicing the tractor electrical system, plow operation and servicing, tractor lubricants and lubrication, preventive maintenance, planting and seeding machinery servicing, repair and servicing of hay machines, servicing grain and corn binders, servicing grain combines and threshers, feed grinders and silage cutters, disk harrows and cultivators, fertilizer distributors and manure spreaders, tractor steering gear, clutch and transmission, power measurement and application, the successful service department, care and servicing of storage batteries, tractor starting and lighting equipment, and the importance of correct engine timing.